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An experimental evaluation of the effectiveness of an audio-tutorial method in teaching vocational agriculture

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AN EXPERIMENTAL EVALUATION OF THE EFFECTIVENESS OF AN AUDIO-TUTORIAL METHOD IN TEACHING VOCATIONAL AGRICULTURE

by

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INTRODUCTION

Programs of individualized instruction are not entirely new additions to the methods used in teaching vocational agriculture at the secondary and post-secondary levels. The supervised farming program has been successfully employed as a teaching method since the inception of vocational agriculture programs. The supervised farming project usually involves a livestock and/or crop project coupled with improvement projects and supporting supplementary practices. Visits to the home farm by the vocational agriculture teacher have been utilized to help plan and complete the program. The problem solving method of teaching has been commonly used to help students with problems relating to their farming and work experience programs.

The extensive use of programmed learning materials carried by various machine media is a new addition to the methods used in teaching vocational agriculture in Iowa.

Little experimental research has been conducted to evaluate the effectiveness of the various methods, media and machines which could be and/or are employed in the teaching of vocational agriculture. Many types of teaching materials are presently available in the schools for use by the vocational agriculture instructor. Machines for utilizing filmstrips, slides, 16 mm movies, overhead transparencies and tape recordings have been used. Video tape equipment, 8 mm film loop projectors, and projecting microscopes have been used to a lesser extent. The synchronized slide-tape machines, multi-media control systems, and computer terminals (computer assisted instruction) are found in very few schools.

The Vocational Education Act of 1963 (20) provided funds for the pur-

chase of audio-visual equipment and materials. The vocational agriculture departments of Iowa used the allotted funds to purchase a wide assortment of audio-visual materials.

The Vocational Education Act of 1963 also provided for the training of persons in occupations related to agriculture. As a result, the scope of instructional programs in vocational agriculture offered by a department has been greatly expanded. Occupational experience programs that involve students working in several occupations, each requiring a somewhat individualized program of supplemental instruction, have been implemented. Mr. Gerald F. Barton[1], Consultant of Agricultural Education, Iowa State Department of Public Instruction, estimated that approximately two-thirds of the vocational agriculture departments in Iowa offered occupational experience training programs in off-farm agriculture during 1969. The production agriculture area has traditionally offered occupational experience training to students of vocational agriculture.

During the 1968-69 school year vocational agriculture was offered in 234 departments in Iowa. These departments served 10,883 day class students, 535 young farmers, and 14,911 adult farmers (6). The most common program of vocational agriculture in Iowa consisted of four years of instruction at the secondary level, an adult farmer class, and/or a young farmer class.

The secondary curriculum in vocational agriculture usually includes animal production and agricultural mechanics in the first year of instruc-

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[1]Barton, Gerald F., Des Moines, Iowa. Work experience opportunities for students enrolled in high school vocational agriculture programs in Iowa. Private communication. 1970.

tion. Crop production, soils management and agricultural mechanics are offered in the second year. The third year course of study is comprised of farm management and agricultural mechanics. The fourth year of vocational agriculture is devoted to agricultural occupations and employment experience with continued instruction in agricultural mechanics. Instructional time has also been used for orientation, farming programs and Future Farmers of America organization activities.

Fifteen area vocational technical schools have been developed within the state of Iowa to meet the need for specialized vocational training. Programs in agriculture were available in 12 of the 15 area vocational technical schools. These schools have increased the need for audio-visual techniques and materials.

The increase in instructional programs offered in vocational agriculture has occurred simultaneously with an increase in the types of audio-visual techniques and equipment adaptable for educational use.

The cost of new instructional media has been high. The addition of sophisticated audio-visual equipment and materials has required a substantial allocation of funds in the school budget plus the use of a rigorous decision-making process. The lack of solid research results upon which to base the decision has confounded the process. Most school district taxpayers have taken pride in having innovative programs and materials used in their schools. The problem has been one of selecting machines and materials that could increase student achievement. Disappointing results in student achievement and unforeseen problems have caused many teachers to more critically examine new technological innovations proposed for use in instructional programs.

A rather pessimistic view of the role of technology in education was discussed by Oettinger and Marks (9). The authors suggested that claims made for some technical innovations may have been exaggerated. The machine or system failure, lack of appropriate programs and acceptance by teachers were among the problems mentioned. The area of individualized instruction also was pursued and the problem of scheduling students and materials for large groups of students was presented as an unsolved situation.

The use of educational technology during the next few years on a massive scale was not foreseen. Over a longer term of years the integration of advanced technology was seen as a possibility.

Oettinger and Marks (9, p. 708) stated the following conclusion:

> Our general conclusion is that the observed combination of institutional rigidity with infant technology will preclude really significant progress in the next decade if significant progress is interpreted, in accord with contemporary literature, as widespread and meaningful adoption, integration, and use of technological devices within the schools. In addition, this discussion should suggest the enormous difficulties that will have to be overcome if educational technology is to be introduced in any decade in the twentieth century.

The authors (9, p. 716) further suggested diversity of experimentation to allow evaluation of useable techniques. The case for diversity was phrased as follows:

> However wasteful in appearance it seems best to encourage as much diversity as possible, as many different initiatives as we can afford once the demands of education have been balanced against those of other needs of our society. We should, in short, plan for the encouragement of diversity, at least in technique.

Humphrey (5, p. 9) has suggested the asking of practical questions about the new media and learning materials. Three questions were posed:

1. Do the equipment and materials cost so much that the schools cannot afford to put them into the classrooms?

2. Do the teachers resist their use because they fear for their own security and because they are not trained in how to use these new items?

3. Are the new media used as they should be as an integral part of learning systems?

The author recommended that the teacher's role should be changed from that of a spoon feeder to that of a diagnostician and prescriber. The use of new methods of dealing with human engineering problems that exist was suggested as a means of improving the performance of learning systems.

The preceding discussion has indicated the need for increased efforts in the evaluation of teaching methods and materials.

In this study the author attempted to determine the effectiveness of an audio-tutorial technique on instruction in vocational agriculture. The technique used consisted of a synchronized slide-tape machine and programmed instructional materials.

A high percentage of Iowa vocational agriculture instructors have access to slide projectors and tape-recorders. Many slides and filmstrips have been purchased for use in teaching vocational agriculture. The findings of this study may help the teachers more efficiently utilize their library of slides through development of integral type programs of instruction.

This study was a part of an experimental project conducted cooperatively by the Iowa State University Department of Agricultural Education and the Iowa Department of Public Instruction. The title of the project was "An Experimental Evaluation of the Effectiveness of Selected Techniques and Resources on Instruction in Vocational Agriculture." Emphasis was placed on testing innovative methods and techniques that may lead to im-

proving instruction in vocational agriculture. Seven instructional techniques were tested in the over-all study. The techniques included: audio-tutorial, single-concept films, video tape, prepared lesson plans, field trips, demonstrations and transparencies.

This study was financed in part from funds from the Iowa Agriculture and Home Economics Experiment Station, but largely from funds from the Research Coordinating Unit under a research grant from Vocational Education Branch (VEA-1963-1964 (a) ancillary funds) Iowa Department of Public Instruction.

Little research has been done on the use of audio-tutorial instructional techniques at the secondary school level. Research at the college level has been reported. The review of literature that follows includes studies on the value of audio-tutorial instructional methods, the assimilation of programs and the measurements of instructional outcomes.

REVIEW OF LITERATURE

Audio-tutorial instructional systems have been the subject of several research studies during recent years. Many combinations of media, materials and methods have been used in the experimental studies. The use of a tape-recorded message to direct students to various activities involving other media and procedures has been the method most frequently occurring in the literature. The bulk of this research has involved samples, or populations, of students enrolled at the college level. Few studies were found that utilized secondary school populations in audio-tutorial research.

The use of simple machines in teaching was first explored by Pressey (12) starting in about 1915. The literature revealed a rather slow and then rapid evolvement from the simple machines of 1915 to the sophisticated systems used in teaching large numbers of students in an individualized manner at the present time.

Brown, Lewis and Harcleroad (2) indicated that it was difficult to generalize about the research completed in the area of programmed learning techniques due to the specific situations in which the techniques were used.

The authors (2, p. 124) offered the following generalizations from the research reported in the area of programmed instruction:

> A student learns when carefully prepared programmed materials are presented by book or machine. Programmed instruction is effective both with a variety of learners (children and adults; college students and military trainees; mentally retarded, gifted, normal, and deaf persons) and in a variety of subjects (chemistry, electronics, psychology, spelling, and others).
>
> Programs and machines are effective in producing increased knowledge in (1) "total teaching" situations in which they are the sole sources of information, or (2) situations in which they

supplement a traditional teaching program.

The most common comparative result is that students learn from programmed materials at least as much as they learn through other methods of instruction.

Programs made with "small steps" between items result in relatively greater learning than "large-step" programs--although programs with steps which are extremely small sometimes yield the opposite effect. The optimal size of steps for programs in various subject fields is yet to be established.

In general, students favorably regard the experience of learning with programmed materials, when it is properly administered.

The use of machine teaching has been greatly influenced by the work completed by Skinner (13). His emphasis has been on programs that provide continuous and immediate reinforcement to the learner. The author suggested that teaching machines offer the advantages of providing (1) frequent and immediate reinforcement, (2) the student can pace himself according to his ability, and (3) the program on the machine is coherently sequenced. The ability to apply laboratory research to a field research situation was also mentioned by Skinner as having importance.

Dr. S. N. Postlethwait et al. (11) has been one of the leaders in audio-tutorial research. The need of low achieving students for instruction in a biology course taught by Dr. Postlethwait was his major concern. These students lacked background material in the biological sciences. The students enrolled in a freshman botany course during 1961 were provided supplementary lectures on audio tape. Diagrams and photographs were also provided as the semester progressed. The use of living specimens in experiments conducted by the participating students was incorporated into the program. Student response indicated further audio-tutorial teaching was feasible.

A section of 36 students was organized as an experimental section of the freshman botany course. The section received all instruction programmed by audio-tape and was directed to associated materials.

No difference in achievement was observed between the experimental and control sections at the end of the semester. The members of the experimental section were interviewed and expressed enthusiasm for the audio-tutorial method of instruction. The audio-tutorial method of instruction was extended to include all sections of the freshman botany course. Increasing enrollments and limited facilities also contributed to the decision to use the audio-tutorial method.

A complete statistical procedure was not used to analyse the achievement of the two groups. Dr. Postlethwait (11) strongly felt that students' attitudes were greatly improved; at least a third more information could be presented in an equivalent amount of time; vandalism was reduced; and based on an absolute standard, the grade distribution had shifted significantly to yield approximately two and one-half times more A's and 50 percent fewer F's than under the conventional lecture-laboratory system.

Several of the procedures suggested by Postlethwait (11) were incorporated into a course organized by Dr. Detroy Green (4), an agronomist at Iowa State University. A freshman course consisting of introductory principles of plant-soil-climate relationships in crop production was organized as a conventional lecture-laboratory situation in the fall of 1965. Due to dissatisfaction with the conventional laboratory an audio-tutorial station type of instruction was established during the winter quarter of 1965.

Lee (7) conducted an evaluation of the agronomy course described in the preceding paragraphs and initiated by Green (4). A total sample of 519

students, representing three quarters of enrollment during 1966-67 were included in the study. Participating in the audio-tutorial laboratory method were 148 students, and 371 students were instructed in the traditional laboratory.

The main purpose of Lee's study was to compare the effectiveness of the audio-tutorial type of instruction with the traditional laboratory method. A laboratory pretest was administered to each student to determine prior knowledge in the agronomy subject matter area. Quizzes were given several times during the quarter and a lecture and laboratory final examination was administered at the end of each quarter. A 2 x 4 foot cubicle was used as a study station. It contained a super 8 mm film loop projector and film cartridges, photographs, diagrams, a mimeo handout and appropriate pamphlets. Other laboratory facilities utilized included a growth bench for seedlings, a demonstration table for large items and other displays of general interest.

A statistical analysis revealed an absence of significant difference in student learning using the audio-tutorial method versus the traditional method of laboratory instruction. A highly significant difference between the mean scores of the weekly laboratory quizzes was reported by Lee in favor of the audio-tutorial method. Several advantages of the audio-tutorial method were also reported by Lee and were briefly as follows: (1) more time was available for teacher preparation; (2) student problems were given prompt attention; (3) make-up sessions and reviews were easily scheduled; (4) fewer class scheduling problems; (5) providing for increased class enrollments was accomplished; and (6) a reduction in the number of students who dropped or failed to complete the course.

Meleca (8) studied the relationship of student abilities to level of achievement in an auto-instructional program. A group of 91 students enrolled in a general biology course at Syracuse University were randomly divided into a treatment section of 48 students and a control group of 43 students. Tests were administered to determine the students' science and biology backgrounds. The Scholastic Aptitude Test (SAT) was used to establish their backgrounds in verbal and mathematical skills. The members of the experimental group were assigned to an individual study booth and taught using audio-tapes, student guide-sheets, illustrative materials, slides and 8 mm single-concept films. Course instructors were available to assist the experimental group and answer questions. The control group was taught using the traditional lecture-laboratory method by college instructors.

Multivariate analysis techniques were applied to determine the factors contributing to the level of achievement of students in the auto-instructional and control groups. This same statistical technique was also used to determine whether there was a significant difference in level of achievement between the two experimental groups. A multiple linear regression technique was applied to determine if existing differences in achievement were significant. The findings revealed no significant difference in mean scores on the pretest for the two groups. Posttest comparisons between the two groups indicated that the mean differences on achievement scores were statistically significant at the .05 level.

The researcher (8) concluded that (1) students using auto-instructional materials can demonstrate satisfactory achievement in college biology; (2) the auto-instructional materials provide an effective vehicle for

transmission of learning in a college biology course, while maintaining individualized instruction; and (3) mathematic and biology aptitude are effective predictors of achievement in the auto-instructional course. The data for the control group did not support this finding.

Meleca (8) suggested that the auto-instructional approach is as good as or somewhat better than the conventional method in teaching college biology; and perhaps a teacher could handle larger numbers of students per class and still provide individual attention.

The success of an audio-tutorial technique used in a bacteriology course at Kansas State Teachers College was attributed by Surdy (18) to the close contact between the student and the instructor. Audio-tutorial techniques had been used in conjunction with the traditional lecture method for several years. Surdy combined the traditional lecture-laboratory parts of the course into one program of individualized instruction. Program construction was employed which permitted a rather personal discussion on the magnetic tapes.

The investigator concluded that the most important benefits derived from the technique were (1) the individualization of instruction, (2) a greater part of the responsibility for learning was returned to the student, and (3) the previously noted close relations developed between the student and the instructor. Some additional positive outcomes of using the system were the more efficient use of space, the simplified laboratory arrangement and the maximum utilization of staff.

The use of multi-media method of instruction was compared by Volker (21) to the use of lecture-demonstration method. The experiment involved 311 students enrolled in high school biology in the Ames (Iowa) High

School. The students were divided into experimental and control groups of six sections each. The experimental group received instruction through audio-tutorial laboratories, programmed instruction, 16 mm films, 35 mm slides, and single-concept films.

An analysis of covariance was used to treat the data obtained from a pretest, achievement test and a posttest. The treated data on total achievement test scores and posttest scores produced significant F-values. Volker concluded that a multi-media system of teaching high school biology was an effective method of transferring knowledge in the experiment. A similar analysis of collected attitude data revealed a significantly higher F-value for the treatment group.

An audio-tutorial technique was employed by Stuck (17) as an experimental treatment in teaching a school law unit within a teacher education course. The 219 students enrolled in the course were randomly divided into experimental and control groups to form a split-plot design. Analysis of variance was used to determine if differences existed between the two groups in knowledge attained. Both experimental groups were given a pretest and posttest to measure knowledge gained over time. A retention test was also administered after a lapse of two weeks time.

The following null hypotheses were proposed by Stuck (17) for testing:

1. There is no significant difference in learning under audio-tutorial methods and traditional methods of instruction.

2. There is no significant difference in learning between the students who have had student teaching and those who have not had student teaching.

3. There is no significant difference in learning between the main effects and interactions of the following variable characteristics of the students: college grade point, whether or not the student has had student teaching, and

the student's respective scores on the pre-, post- and retention tests.

4. There is no significant difference in the retention of the content between the students having been taught by the audio-tutorial and the traditional lecture method.

The only significant F-value emerging from the study, that was pertinent to the study, was in the two methods of instruction. Ho_1 was rejected whereas, Ho_2, Ho_3 and Ho_4 were not supported by statistical findings which would have permitted their rejection. Stuck concluded that the audio-tutorial method of instruction was significantly better than the lecture method. The development of course materials to teach the course by the audio-tutorial method was also recommended.

The students who participated in the lecture method of instruction used 38.44 percent more time than those who used the audio-tutorial method. Stuck suggested that the audio-tutorial method was an appropriate method of instruction based on the time saved. No reinforcement was used with the audio-tutorial group during the experiment. The investigator suggested that an instructor's presence during further experiments might be an improvement in the audio-tutorial method reported in this study.

The effects of four treatments in audio-tutorial teaching upon the factual recall and performance of a graphic production skill were investigated by Smellie (14). The feasibility and effectiveness of using an audio-tutorial method in teaching a graphic production skill, the effect of practice, the effect of pacing, and the interaction between practice and pacing were the stated purposes of the experiment.

A sample composed of 100 subjects in an audio-visual production class at Indiana University was randomly assigned to an audio-tutorial carrel

containing one of the four treatments. Subject-paced instruction, experimenter-paced instruction, no practice and required practice were combined to make-up the four treatments. A factual information and performance test was administered immediately following the treatment.

The researcher (14) analyzed the data using analysis of variance with a simple 2 x 2 factorial design. The findings indicated no significant effect resulting from pacing, practice and the interaction of pacing and practice. The author concluded that the audio-tutorial method should be considered as having definite use as a method of teaching certain graphic production skills.

The effectiveness of a teaching machine program in a first year college chemistry course was investigated by Geller (3). One hundred twenty nonchemistry majors were randomly divided into two groups. The control group was taught by a regular instructor in the course by the lecture-demonstration. The treatment group received instruction through the use of a linear program of 539 frames developed according to Skinnerian program learning psychology.

The investigation was proposed to determine the effect of a teaching machine on learning, retention, interest in chemistry and the relationship of the student's reading proficiency on achievement. A pretest, posttest and retention test were administered. In addition, a questionnaire on attitude toward subject matter, the program, and teaching machines was completed. No significant difference between the experimental groups was reported when the pre-, post and retention test data were analyzed. The results indicated that immediate learning and retention were not enhanced by the use of the teaching machine, greater interest was not demonstrated by

the treatment group, and the student's reading proficiency level did not effect learning. The experimental and control students achieved equally well.

The author (3) recommended that the teacher should assist the students using the teaching machine in order to enrich the subject and provide formal reinforcement. The use of teaching machines in geographic areas, domestic and foreign, where there may be a scarcity of trained teachers was also included as a recommendation.

The effectiveness of using film strips and slides in teaching vocational agriculture was studied by Solstad (16). The author made 35 mm slides of approved practices in swine and dairy production used on the farms of class members. These slides were then combined with commercially produced slides. Treatment and control groups were obtained from the results of a subject matter pretest and scholastic aptitude scores.

Both groups received traditional instruction through the use of the blackboard and discussion sessions. The treatment group was then exposed to the slide program. The control group was given an opportunity to study from books and bulletins and to receive assistance from an instructor. A post-test was given both groups which tested both factual information and problem solving ability.

No significant difference was found between the mean scores of the two groups. However, Solstad reported higher experimental group means based on the post-test over the units in swine and dairy production.

Wendorff (22) compared the effectiveness of automated instruction and the traditional lecture-demonstration procedure. A total of 20 students enrolled in the farm and ranch operators short course at the University of

Nebraska were randomly assigned to two treatment groups. The experimental group was subjected to the automated teaching machines and the control group was subjected to the lecture-demonstration method. The experimental program consisted of an 89 slide, 45 minute, four-track audio-tape on corn planter alignment and calibration. Two test instruments were prepared, measured laboratory performance and the other achievement on factual, procedural and operational information of corn planters. The same tests were used as the pretest and posttest.

The experimental and control groups both had an instructor available during the class sessions to answer questions.

The data were analyzed by a comparison of mean differences between pretest and posttest scores using a "t" test statistic.

The results of the analysis of the data revealed no significant difference between the mean scores of the two groups recorded for the performance test. However, a highly significant difference between the two groups was found in the mean scores for the factual, procedural and operational information tests.

Wendorff concluded that automated teaching machines could be used successfully to transmit information. Freeing the teacher from the lecture situation to provide more individual assistance to his students was an additional benefit.

Petersen (10) conducted an investigation to evaluate the effectiveness of the audio-tutorial technique of instruction presenting sequence-programmed lessons using an automatically synchronized 35 mm slide tape machine. The method was compared with the traditional method of instruction in a small power equipment course at Iowa State University.

A population of 28 students, primarily juniors and seniors, enrolled in the course were randomly divided into treatment and control groups. Background information on attitude, background of knowledge and other pertinent information were obtained. A pretest, laboratory test and posttest were administered to each student.

Separate lecture and laboratory programs were prepared for use by the group taught by the audio-tutorial method. The appropriate data were then treated with t-test, correlation, step-wise regression and an analysis of covariance statistical techniques. The findings revealed a significant difference at the .01 level in favor of the audio-tutorial method when it was used to present factual information. No significant difference was observed when the audio-tutorial technique was used in a laboratory situation. No significant differences were found between the treatment and control group means for the selected variables.

The investigator concluded that the audio-tutorial technique studied could (1) be effectively used for individualized instruction, (2) reduce the time required to teach students, and (3) increase student motivation.

The purpose of a study by Tindall (19) was to determine the relationship of class size and department enrollment to the achievement of students in high school vocational agriculture when certain selected instructional media were used. This study was a companion study to the one conducted by the author as a part of the larger project entitled, "An Experimental Evaluation of the Effectiveness of Selected Techniques and Resources on Instruction in Vocational Agriculture."

A random selection of six high school vocational agriculture departments that met certain criteria established by the project members was

drawn for each of seven media treatments. The seven media were: audio-tutorial, demonstration, field trip, prepared lesson plan, single-concept films, transparency and video-tape. Four subject matter areas were chosen as appropriate material for the four grade levels. They were animal health for the ninth grade students, commercial fertilizers for the tenth grade students, small gas engines for the eleventh grade students and farm credit for the twelfth grade students. A pretest was administered to all students in the 42 Iowa vocational agriculture departments cooperating in the study prior to the treatment period. A posttest was given to the students upon completion of 14 days of instruction. The 42 vocational agriculture departments were divided into enrollments of 36 to 53 and 54 to 79 students.

When comparing the gain in achievement of students in animal health, small gas engines and farm credit subject matter, it was revealed that students using the audio-tutorial technique in large departments scored higher than did the students in small departments. However, students in the small departments scored higher than the students in large departments when the audio-tutorial technique was used with the small gas engines instruction. For audio-tutorial media group, a highly significant correlation between achievement and department enrollment (.32) was found.

The mean gain in achievement was higher for students in small classes in the animal health, commercial fertilizer and small gas engines subject matter areas than in large classes. The students in large classes using the audio-tutorial technique had higher mean scores than those in small classes. Tindall (19) recommended that, based on further collaborating research, audio-tutorial, single-concept films and video-tape media be considered for use in large classes and for departments with over 60 students

enrolled.

An investigation to determine the relationship between the instructor's knowledge of subject matter and their students' level of academic achievement was conducted by Beane (1) as part of the previously mentioned larger study. With the exception of having the instructors complete a 45 item test, Beane's procedure was similar to that of Tindall's (19). The 45 item test over subject matter was given the instructors before the instructional media and materials in the four subject matter areas were distributed. A posttest was given the instructors at the conclusion of the instruction period. On the basis of their pretest scores and differences between the pretest and posttest scores, the instructors were placed in three equal-sized groups: high, medium and low. The relationships between the instructor's knowledge of the subject matter and student achievement were evaluated using the analysis of variance and t-test techniques.

A highly significant difference was found between the instructors' pretest and posttest mean scores. When the mean scores of students were grouped according to their instructor's knowledge of the subject matter and the form of instructional media, no significant differences were revealed.

Beane also analyzed the relationship between instructor's knowledge of the subject matter and student achievement. The findings revealed that there were significant differences at the .05 level of confidence in the posttest scores. The highest mean posttest scores were achieved by students in the animal health, commercial fertilizers and farm credit classes whose instructors were in the medium group. In the small gas engines unit, the highest mean scores were made by students whose instructors were in the low group.

The loss of "subject structure" through the use of completely programmed matter was suggested by Pressey (12), who has been mentioned previously by this author as an early experimenter in the educational technology field. Pressey noted that programmed matter is hard to use for review and does not present the learner with integrative and judgmental learning experiences because of the programs' little "frames" format.

He believes the use of auto-instruction should follow the use of a well prepared text, field trips, demonstrations or experiments. The auto-instruction would follow the preceding methods to aid in the clarification and stabilization of cognitive structure through the correction of misconceptions.

The author (12, p. 452) suggested the following use of auto-instruction techniques with technical matter:

> In difficult matter such as a science text or industrial or military training manual, bits of autoinstruction may be needed more frequently; each step in the solution of a difficult problem may need such autoelucidation. But the manual or text need not be fragmented into thousands of frames. Problems may be explicated in autoinstructional matter supplementary to the text; and there, or perhaps every 3 or 4 pages in the book, clusters of autoexplicating queries may keep check on understanding. But a book's structured coherence and orderliness of presentation, and its convenience for overview, review, and reference, can be kept.
>
> If the autoinstruction is thus to follow presentation of what is to be learned, then (like a good tutor or teacher) it will deal only with issues which need further clarification or emphasis. Such adjunct autoelucidation will not cover everything, may jump from one point to another or even back and forth. It will be very much shorter than present "programs," which attempt both to present matter to be learned and autoinstruct about it in the same aggregate. Being so different, such supplemental autoinstruction might well be given a different name, as autoelucidation or explication.

Pressey (12, p. 455) suggested the following uses of auto-instructional materials be tested in the future:

> An "adjunct autoinstruction" is urged which keeps, makes use of, and enhances meaningful structure, the autoinstruction serving to clarify and extend meaningfulness. Texts, manuals, laboratory exercises, instructional moving pictures and television would be kept (though often improved), and the autoinstruction would aid in their use and increase their value. The materials would be perhaps only a tenth as bulky as present programs; and being objective, their use could be greatly facilitated by automating devices.
>
> Evaluations should not merely (as is now projected) compare the merits of various "orthodox" programs. Those should be compared with such adjunct autoinstructional materials as here advocated. Adaptability should be compared for use with other media as books and movies and other methods as guided independent study. Convenience and cost for continuing general use should be hard-headedly appraised. The prediction is ventured that in all respects adjunct autoinstruction will be found far superior, time and work saving will be great yet more will be accomplished--courses often completed in half the usual time, years saved but nevertheless more accomplished in school and college, industrial and military training tasks reduced perhaps a third in length and all with great time and trouble saved instructional staffs. Then at long last the "industrial revolution" in education may come about which the writer predicted (Pressey, 1932) just 30 years ago. Further, somewhat as the practical testing movement from the first world war on greatly stimulated and aided research and theorizing regarding abilities, so autoinstruction may get research on learning out from under its long dominance by comparative psychology and confinement in the laboratory and evolve vigorous new theory.

This review of literature illustrated the value of an effective teacher in the educational process. The effectiveness of auto-instructional devices is dependent on the participation of a teacher as a motivating force and as an initiator of interest in the subject area.

Auto-instructional devices have demonstrated usefulness in making more efficient use of a student's time, adding variety to the learning situation, allowing a successful teacher to reach more students, and in effectively teaching technical matter. Much research needs to be done to establish the specific combinations of media and materials that can be effective in more efficiently teaching all types of subject matter.

METHOD OF PROCEDURE

The purpose of this study was to determine the effectiveness of an audio-tutorial technique in the teaching of selected program of study areas in vocational agriculture. The effects of certain home, student, teacher and school characteristics on student achievement were also considered in the investigation.

Seven different treatment and control groups comprised a larger study entitled, "An Experimental Evaluation of the Effectiveness of Selected Techniques and Resources on Instruction in Vocational Agriculture." This study constituted one part of the larger study. The methods of instruction included: (1) audio-tutorial, (2) demonstrations, (3) field trips, (4) overhead transparencies, (5) prepared lesson plans, (6) single-concept films, (7) video-tape, and (8) control.

Criteria were established to determine those schools which could be used as a sample for this study. The criteria were: (1) separate classes were held for each of the four grade levels, (2) the teacher must have had at least one year of teaching experience, (3) at least seven and no more than 22 students were enrolled in each class and (4) a minimum of 35 students were enrolled in the vocational agriculture program at the high school level.

Information regarding criteria were obtained by questionnaire during the 1968-69 school year. From the population of schools that met the criteria six schools were randomly assigned to each of seven treatment groups and a control group. Presented in Table 1 are the names of the 12 schools that comprised the audio-tutorial and control groups, the names of instruc-

Table 1. Number of students by technique, school, instructor and subject matter area

Technique	School	Instructor	Subject matter area				Total
			Animal health	Commercial fertilizers	Small gasoline engines	Farm credit	
Audio-tutorial	Atlantic	Ronald Beaver	12	12	13	10	47
	Edgewood	William Kenney	16	20	16	12	64
	New Hampton	Robert Bell	20	21	16	19	76
	Newton	Emeron Dettmann	16	13	17	11	57
	Sioux Center	William Godsey	17	15	18	21	71
	Sumner	John Scott	16	17	7	11	51
Total			97	98	87	84	366
Control	Alta	Harold Carstens	12	7	8	8	35
	Everly	Dale Fisher	7	9	9	11	36
	Hartley	Harold Woodard	12	8	10	9	39
	Rock Valley	Donald Kaberna	10	9	8	10	37
	Sac City	Larry Redding	10	8	14	8	40
	West Liberty	Richard Wehde	16	10	10	9	45
Total			67	51	59	55	232
Grand total			164	149	146	139	598

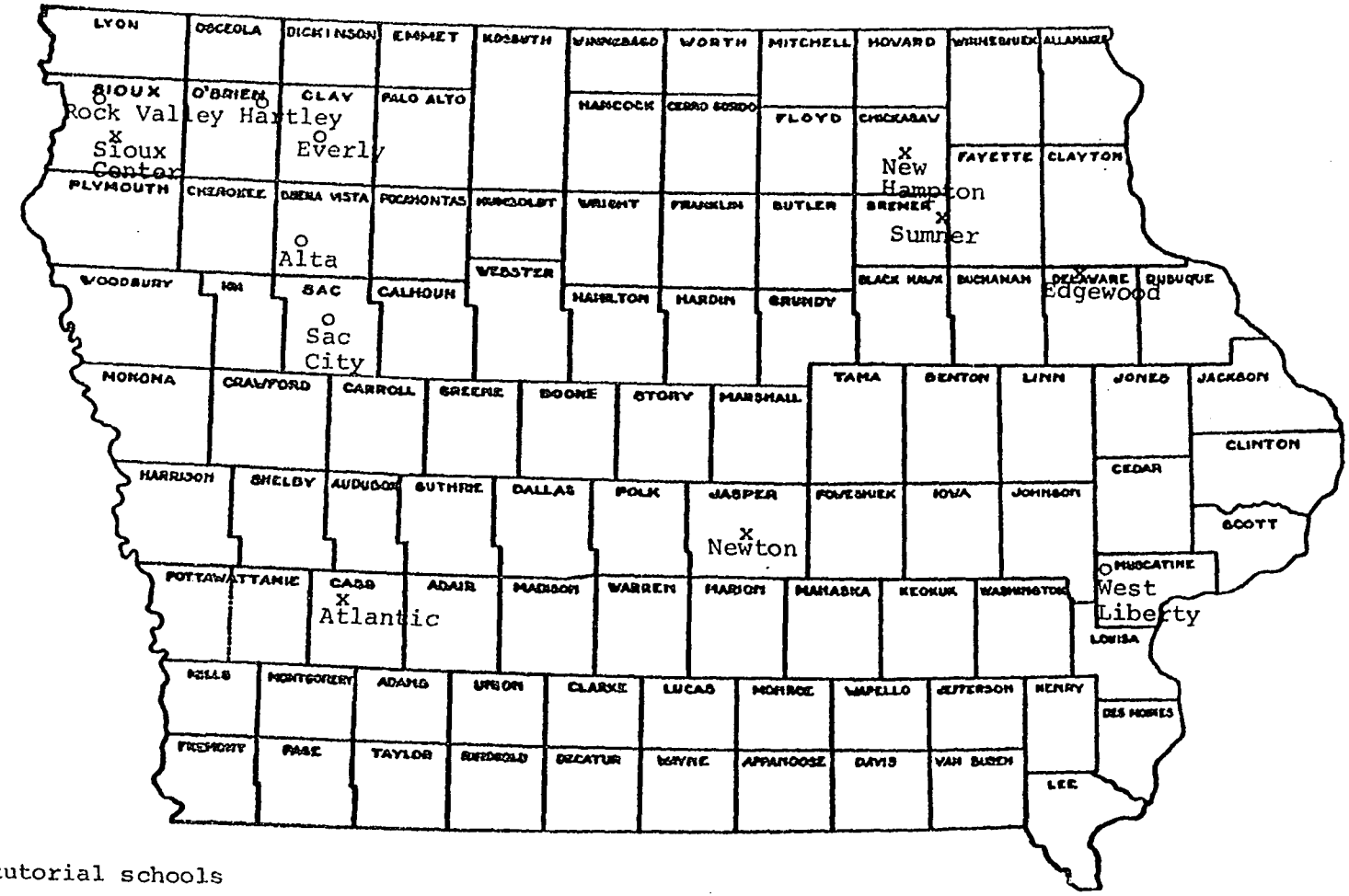
tors and the enrollments. The geographic locations of the selected schools are shown in Figure 1.

Selection of Audio-tutorial Equipment

Most vocational agriculture instructors have tape-recorders and 35 mm slide projectors available in their school systems. This fact was considered as the selection of equipment was investigated. The investigator tried during the preparation of the materials used in this experiment, to stay within the potential programming capabilities of most teachers of agriculture. Very few commercially prepared programs are available for use in teaching vocational agriculture.

Various types of equipment are commercially produced which are capable of presenting a synchronized slide-tape program. One of the main differences in the audio-tutorial equipment viewed was in the audio section. The audio section was available in two or four track recording capability. Four track equipment was first considered by the author as desirable due to the multiple-choice question format capability of the tapes. Three tracks of the tape were available for three-part multiple-choice questions and the fourth tape track was used for the discussion. However, this system was not used because of high rental cost per unit and the need for using expensive commercially prepared programs. The author concluded, after several weeks of evaluating various audio-tutorial devices, that a reasonable priced, less complex and more easily programmed system should be selected.

The use of a standard tape recorder and 35 mm slide projector was evaluated, but the need for a synchronized tape-slide machine was suggested by the review of literature and discussions with commercial suppliers. The



x Audio-tutorial schools

o Control schools

Figure 1. Geographical location of the participating schools

synchronized type of operation offered ease of operation by students, proper sequencing of slides and fast interchanges of programs. Machines were rented which offered a two-track tape, synchronizing capability, circular storage for 80 slides and a student controlled start-stop control. Two of these machines were rented for each of the six schools in the treatment. Financial considerations in combination with limited study station space available at the schools limited the number of machines rented. An audio-tutorial machine of the type used with the audio-tutorial experiment is shown in Figure 2.

An adjustable type and a three inch lens were ordered with each machine to enable its use with large groups and in individual instruction. Tape cartridges with a 20 minute playback capacity were ordered. The 20 minute cartridges were the maximum length available from the supplier. Preparation time considerations indicated the desirability of using one 20-minute tape presentation per lesson.

Twelve 18 inch by 30 inch self-supporting projection screens were constructed by the researcher. Two of the screens were furnished each school for use with individual and small group instructional techniques. One machine with both recording and playback capability and eleven machines with only playback capability were rented for a one month period.

Development of Materials

A subject matter area was selected for each of the four grade levels (ninth, tenth, eleventh, and twelfth) in vocational agriculture by the project staff. Subject matter appropriate to the program of study used by most vocational agriculture departments involved in the study was selected.

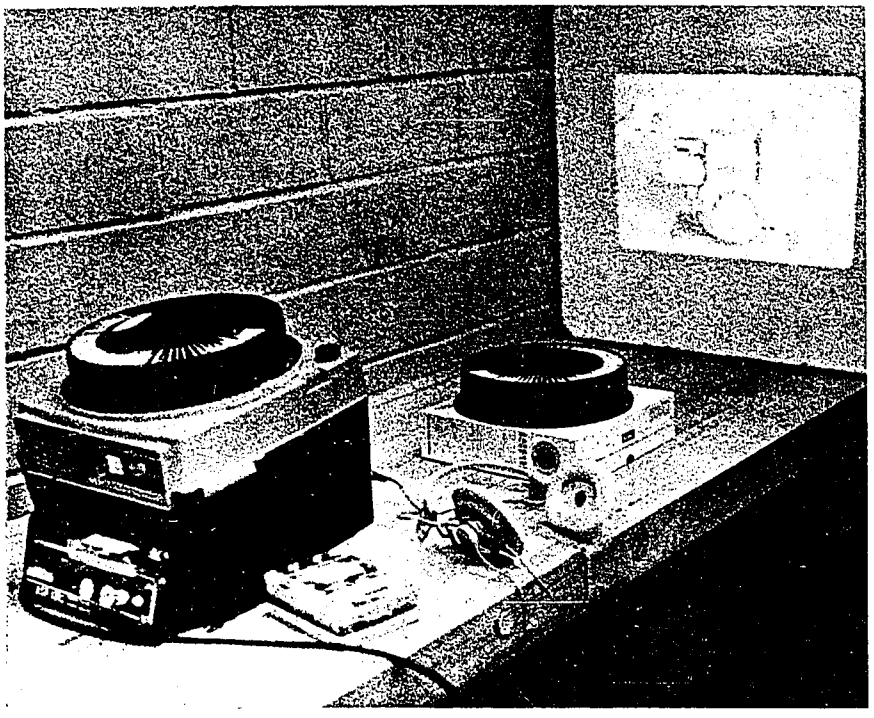


Figure 2. Fully equipped audio-tutorial study station

Figure 3. Student using the audio-tutorial technique for individual study

Following is a description of the four areas selected:

1. Animal health (ninth grade) - the identification, causes, prevention, and control of the major swine, sheep and cattle parasites and diseases.
2. Commercial fertilizers (tenth grade) - the study of the essential plant food elements, crop hunger signs, soil sampling, liming, fertilizer application rates and selection of fertilizers.
3. Small gas engines (eleventh grade) - the principles of operation of the two- and four-stroke cycle engines, functions of the engine parts, measuring devices and preventive maintenance in small gas engines.
4. Farm credit (twelfth grade) - budgeting principles, types of loans, sources of credit, interest rates, collateral, credit instruments and the use of farm credit.

A 14-day teaching outline (Appendix) was developed which included the overall objectives, specific objectives for each day, reference materials and reading assignments. The same reference material and teaching outline were provided to all 12 schools participating in the experiment. The treatment schools used the audio-tutorial technique in their instructional program and could not use any of the other media that were tested in the larger study. The control schools were not permitted to use audio-tutorial techniques, or any of the other six techniques that were tested in the study. The schools using audio-tutorial and the control schools were allowed to use any other technique that they wished.

Four audio-tutorial programs were prepared in each of the four subject matter areas being taught. Presented in Table 2 are the titles, audio tape

Table 2. Audio-tutorial programs by subject matter area, title, length in minutes, number of slides and day used

Subject matter area	Title	Length in minutes	Number of slides	Day used
Animal health	Maintaining animal health	17	29	2
	Cattle parasites	19	42	5
	Swine diseases	17	20	9 & 10
	Planning a general livestock health program	19	28	12
	Total	72	119	
Commercial fertilizers	Importance of fertilizer use	19	28	1
	Soil sampling	17	23	5
	Interpreting the soil test report	17	18	8
	Fertilizer rates	16	11	11
	Total	69	80	
Small gasoline engines	2 and 4 stroke-cycle engines	15	23	1
	Measuring devices	16	30	6
	Carburetion	19	59	7
	Magneto-ignition	19	54	12
	Total	69	166	
Farm credit	Need for credit	18	36	1
	Loan types	12	10	6
	The borrower	14	17	10
	Credit instruments	16	15	12 & 13
	Total	60	78	

time in minutes, and the day the treatment was used. In actual use, the programs required time in excess of that shown in Table 2 because the programs required student interaction with reference materials and worksheets. The students were not restricted in respect to time. Not all of the specific treatment day objectives were covered in the same depth in each audio-tutorial program due to fixed program length.

All types of resource materials were used in the preparation of the slides. Several of the slide programs were photographed from live situations. Other programs used worksheets, commercially prepared slides and magazines as sources of slide content.

All slide reproduction was done by the Photo Service of Iowa State University. A total of 443 slides were used per school with 2,658 slides prepared for the six treatment schoools.

Scripts for the audio-tape recordings were prepared in outline and recorded by the author. The outline was practiced several times, much as a lesson plan might have been rehearsed, and then recorded. Duplicates were made by the investigator using the 16 original recordings to reproduce a total of 96 tapes. The tapes were then played again and a silent synchronizing pulse was placed on the second track of the audio tape.

An attempt was made to keep the audio discussion accompanying each slide to 15 to 20 seconds with a five second pause between slides to allow students to stop the machine if that option was taken or required. This procedure was suggested by CBS Laboratories[1] in a private communication.

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[1]CBS Laboratories, Stamford, Connecticut. Audio visual system programming. Private communication. 1969.

The audio length per slide was varied depending on the type of subject matter programmed.

A 60-item test was developed by project members who were not involved in treatment preparation and application. This was used as both the pretest and posttest. An item analysis of the posttest revealed the following coefficients of reliability: (1) animal health - .85, (2) commercial fertilizers - .85, (3) small gas engines - .85, and (4) farm credit - .87.

Training of Teachers

All instructors who participated in the experiment were given a one-half day introductory briefing at three different locations throughout the state to acquaint them with the experimental program. A one and one-half day training session was held on the Iowa State University campus prior to the implementation of the 14-day instructional period.

The instructors selected to use the audio-tutorial technique were provided the reference materials, outline and programs. They were instructed in the use of the materials and the audio-tutorial equipment. It was explained to them the necessity of not using the other treatment media during the treatment period. The instructors were asked to present the programs to the entire class at a time they considered appropriate on the designated treatment day. Study stations were to be provided in the vocational agriculture department, school media center or other areas for use by individual or small groups of students. A student utilizing the audio-tutorial technique in individual study is shown in Figure 3. Students could review the programs as many times as they desired or time permitted.

The instructors in control schools were instructed in the use of the

reference material and outline. They were also informed of the restriction which prohibited the use of the treatment media during the 14 day duration of the research program.

During the experimental period the author visited five of the audio-tutorial treatment schools twice and made one visit to the sixth school. The one visit to the sixth school was supplemented by a visit by another project member. These visits were used to solve any unforeseen problems that had arisen in the treatment schools. In addition, the visits were used to acquaint the researcher with the actual operation of the audio-tutorial technique of instruction. At least one visit was made to each control school by a project staff member.

Collection of Data

A 60-day period prior to the start of this experiment was utilized in collecting information about each of the students. The information was collected through the cooperation of the school counselors. They administered the following tests:

1. Otis Quick-Scoring Mental Ability,
2. Kuder General Interest Survey (Form E),
3. Nebraska Agriculture Achievement,
4. Differential Aptitude Test - Mechanical Section,
5. Differential Aptitude Test - Abstract Section, and
6. Differential Aptitude Test - Verbal Section.

The socio-economic background information on the students was collected by questionnaire. A selected list of activities was submitted to each of the students and they were asked to check those activities which

they had at some time actually performed.

The Minnesota Teacher Attitude Inventory and a pretest and posttest on teacher knowledge was completed by each of the participating teachers. The latter were studied in depth by Beane (1). Additional information collected on the teacher included years of tenure at present school, total years of teaching and educational level.

The 60-item test used both as the pretest and posttest was administered by the school counselor. The pretest was given the day prior to the start of the experiment and the posttest was administered on the last day of the experiment. The treatment period started on March 24, 1969.

Analyses of Data

The randomness of this experiment was limited to the selection of schools for assignation as a treatment or control school. The mean scores of the classes within the schools were used in analyzing the data. The data gathered from the schools were coded and placed on IBM cards. Analyses were conducted at the Iowa State University Computation Center. Statistical methods used in analyzing the data included analysis of variance, analysis of covariance, a two-factor experiment with repeated measures and stepwise regression.

The analysis of variance model used in this study to analyze the differences among the treatment and control class means for the pretest and posttest mean scores was as follows:

$$Y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$$

where

Y = class pretest or posttest means per treatment, per school,

μ = overall grand mean of the pretest or posttest,

α = group deviation,

ε = random error associated with the class pretest or posttest means,

$i = 1, 2$, and

$j = 1, 2, \ldots, 6$.

The model used in the analysis of covariance was as follows:

$$Y_{ij} = \mu + \alpha_i + \beta_1(X_{ij} - \bar{X}..) + \beta_2(X_{ij} - \bar{X}..) + \ldots + \beta_k(X_{ij} - \bar{X}..) + \varepsilon_{ij}$$

where

Y = class posttest mean per treatment, per school,

μ = overall grand mean of the posttests,

α = contribution of treatment effect (audio-tutorial vs. control),

$\beta_1, \beta_2, \ldots, \beta_k$ = regression coefficient,

X_{ij} = covariate per treatment,

$\bar{X}..$ = covariate grand mean,

ε = random error associated with the class posttest means,

$i = 1, 2$,

$j = 1, 2, \ldots, 6$, and

$k = 1, 2, 3$.

A two-factor experiment with repeated measures as presented by Winer (23) was completed as a part of the analyses. The model for this analysis was as follows:

$$Y_{ijk} = \mu + \alpha_i + \varepsilon_{ij} + \beta_k + (\alpha\beta)_{ik} + \delta_{ijk}$$

where

Y = class pretest and posttest means per treatment, per school, per repeated measure,

μ = overall grand mean of the pretest and posttest means,

α = contribution of treatment effect (audio-tutorial vs. control),

ε = error associated with the treatment effect (audio-tutorial vs. control),

β = effect of the repeated measure (pretest and posttest),

$(\alpha\beta)$ = interaction of the treatment (audio-tutorial vs. control) and the repeated measure (pretest and posttest),

δ = random error associated with the class pretest and posttest means,

$i = 1, 2,$

$j = 1, 2, \ldots, 6,$ and

$k = 1, 2.$

To aid in accounting for the variation in the mean posttest scores, a stepwise regression analysis was introduced. The model used in this analysis was as follows:

$$Y_{ij} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon_{ij}$$

where

Y = class posttest mean per treatment, per school,

β_0 = Y intercept or height of regression line at origin,

$\beta_1, \beta_2, \ldots, \beta_k$ = regression coefficients,

$X_1, X_2, \ldots, X_k$ = independent variables used to predict posttest class means,

ε = random error associated with the class posttest means,

$i = 1, 2,$

$j = 1, 2, \ldots, 6,$ and

$k = 1, 2, \ldots, 10.$

FINDINGS

The main purpose of this study was to determine the effectiveness of an audio-tutorial technique in the teaching of selected program of study areas in vocational agriculture. In addition, the effects of certain home, student, teacher and school characteristics on student achievement were also considered in the analyses of the data.

The four subject matter areas of (1) animal health, (2) commercial fertilizers, (3) small gasoline engines and (4) farm credit were used as subdivisions in describing the findings. The acceptance or rejection of the null hypotheses was based on the evidence presented in the findings. The hypotheses were postulated to aid in achieving the main objective of the study. Class means were treated as the basic observations in the analyses conducted in this study since the schools were randomly selected. The statistical models used in analyzing the data are found in the Method of Procedure.

Animal Health

A 60-item test was used as both the pre- and posttest in measuring student achievement. Each test answer sheet was then graded three times by the Iowa State University test scoring service using three different scoring systems. These systems were defined as (1) overall, (2) treatment day and (3) specific objectives. All 60 questions were used in obtaining possible individual scores in the overall objectives method. Only those questions pertaining to the treatment day objectives were included in the treatment day objectives method. The treatment days are reported in Table 2 and the daily objectives are presented in Appendix A. The questions used

in the specific objectives system were selected after it was determined they tested the specific audio-tutorial program objectives.

The means for the dependent variable (posttest) scored by the three methods, and the overall mean scores, are presented in Table 3 together with the 38 independent variables associated with instruction in animal health in the audio-tutorial and control schools. The means in Table 3 provided the information concerning the treatment effects which were then tested against the variations in the class means.

Ho_1: There were no differences between the specific objectives mean pretest scores of the audio-tutorial and control schools for the animal health unit.

The mean pretest scores by specific objectives as shown in Table 3 reveal that the audio-tutorial schools had a mean score of 37.10, whereas, the control schools had a mean pretest score by specific objectives of 37.03. A single classification analysis of variance was calculated for the three methods of scoring the pretest reported in Table 3. The three methods of scoring the pretest and posttest and their respective F-values are reported in the tables to indicate trends in the F-value to increase or decrease in magnitude. Only the F-value for the specific objectives mean scores was used to determine the acceptance or rejection of the null hypotheses. The F-value obtained (.00) revealed that the mean pretest scores by specific objectives were not significantly different and the hypothesis Ho_1 was not rejected. There were no differences between the mean pretest scores by specific objectives for the animal health unit in the audio-tutorial and control schools. In addition, the F-values obtained for the overall (.03) and treatment day objectives (.00) mean pretest scores and

Table 3. Means for dependent and independent variables for the animal health unit by instructional technique

Variable	Technique		Overall mean
	Audio-tutorial	Control	
Pretest - overall objectives	33.45	34.04	33.74
Pretest - treatment day objectives	34.50	34.71	34.61
Pretest - specific objectives	37.10	37.03	37.06
Posttest - overall objectives	48.06	57.57	52.82
Posttest - treatment day objectives	48.30	57.37	52.83
Posttest - specific objectives	51.43	59.68	55.55
Intelligence quotient	99.41	101.97	100.68
Mechanical aptitude	62.96	58.64	60.80
Abstract aptitude	54.64	59.73	57.18
Verbal aptitude	53.09	56.38	54.74
Agriculture achievement	38.67	57.40	48.04
Outdoor interest	71.67	70.53	71.10
Mechanical interest	52.08	52.09	52.08
Computational interest	50.94	52.03	51.49
Scientific interest	36.21	34.98	35.59
Persuasive interest	54.29	57.45	55.87
Artistic interest	42.68	40.13	41.40
Literary interest	51.73	46.55	49.14
Social service interest	47.56	38.64	43.10
Clerical interest	59.23	47.92	53.57
Student skill sheet	38.98	45.67	42.32
Crop acres	183.39	228.22	205.80
Noncrop acres	55.94	32.33	44.13
Total farm acres	235.06	260.55	247.81
Animal units	112.01	123.99	118.00
Number of older brothers	0.80	0.70	0.75
Number of younger brothers	0.86	1.02	0.94
Number of older sisters	1.26	0.70	0.98
Number of younger sisters	0.87	0.79	0.82
Total number of brothers and sisters	3.80	3.22	3.51
Semesters of science	1.49	1.88	1.69
Semesters of mathematics	1.92	1.98	1.95
Semesters of business	0.28	0.17	0.22
Semesters of vocational agriculture	2.04	1.98	2.01
Semesters of industrial arts	0.38	0.14	0.26
Teacher knowledge	32.33	33.67	33.00
Teacher personality	43.67	52.67	48.17
Class size	15.67	11.50	13.58
Department size	59.33	39.17	49.25
Teacher tenure	9.66	4.83	7.25
Teacher experience	13.33	6.83	10.08

reported in Table 4 were not significantly different.

Ho_2: There were no differences between the combined specific objectives mean pre- and posttest scores of the audio-tutorial and control schools for the animal health unit.

Ho_3: There were no differences between the specific objectives mean pre- and posttest scores of the audio-tutorial and control schools for the animal health unit.

Table 4. Analysis of variance on mean pretest scores for animal health by overall, treatment day and specific objectives

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Overall objectives				
Treatment	1	1.05	1.05	0.03
Error	10	308.60	30.86	
Total	11	309.65		
Treatment day objectives				
Treatment	1	0.14	0.14	0.00
Error	10	468.68	46.87	
Total	11	468.83		
Specific objectives				
Treatment	1	0.02	0.02	0.00
Error	10	597.41	59.74	
Total	11	597.43		

Ho_4: There were no differences between the magnitude of change from the specific objectives mean pre- to posttest scores of the audio-tutorial and control schools for the animal health unit.

A two-factor experiment using repeated measures was used to test the preceding three hypotheses. Winer (23) suggested, in this particular type of analysis, that two separate error terms should be used in testing the hypotheses. The differences between the pre- and posttest means would be confounded in considering the effects tested in Ho_2. The appropriate error term (error a) for this hypothesis is large and reduces the chance of significance. The testing of Ho_3 and Ho_4 involved a different error term (error b) which was not affected by confounding and results in a more sensitive test. The results of the analysis of the two-factor experiment using the repeated measures of specific objectives mean pre- and posttest scores are presented in Table 5. The nonsignificant F-value (1.08) supports the hypothesis Ho_2 that there were no differences between the combined specific objectives mean pre- and posttest scores of the audio-tutorial and control schools. Hypothesis Ho_2 was not rejected. Data presented in Table 5 reveal nonsignificant F-values for the overall objectives (2.04), and for the treatment day objectives (1.43) combined mean scores for the pre- and posttest. Data in Table 6 reveal the specific objectives combined mean scores for the audio-tutorial (44.26) and control schools (48.36) differed by 4.10 points.

Hypothesis Ho_3 was rejected when a highly significant F-value (78.11) was obtained from the analysis of the specific objectives mean scores. Highly significant F-values were also revealed in Table 5 for the overall objectives (126.74) and for the treatment day objectives (86.67) mean

Table 5. Analysis of two-factor experiments using the repeated measures of mean pre- and posttest scores by overall, treatment day and specific objectives from classes taught the animal health unit

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Overall objectives				
Method	1	153.12	153.12	2.04
Error (a)	10	752.22	75.22	
Time	1	2182.75	2182.75	126.74**
Method x time	1	119.35	119.35	6.93*
Error (b)	10	172.23	17.22	
Total	23	3379.65		
Treatment day objectives				
Method	1	129.18	129.18	1.43
Error (a)	10	906.30	90.63	
Time	1	1993.26	1993.26	86.67**
Method x time	1	117.84	117.84	5.12*
Error (b)	10	229.98	23.00	
Total	23	3376.56		
Specific objectives				
Method	1	100.65	100.65	1.08
Error (a)	10	933.81	93.38	
Time	1	2050.72	2050.72	78.11**
Method x time	1	103.71	103.71	3.95
Error (b)	10	262.51	26.25	
Total	23	3451.40		

**Significant above the one percent level.

*Significant above the five percent level.

Table 6. Combined mean pre- and posttest scores by specific objectives of the audio-tutorial and control schools for the animal health unit

Method	Pretest	Posttest	Total
Audio-tutorial	37.09	51.42	44.26
Control	37.03	59.68	48.36
Total	37.06	55.55	

scores. The mean posttest scores for the audio-tutorial and control schools were found to be different than the mean pretest scores of these schools. A significant amount of knowledge as measured by the pre- and posttests was gained during the 14-day instructional period.

The analysis of variance test for hypothesis Ho_4 provided a nonsignificant F-value (3.95) and the hypothesis was not rejected. There were no differences between the magnitude of change from the specific objectives mean pre- to posttest scores of the audio-tutorial and control schools for the animal health unit. Presented in Table 5 are the F-values for the repeated measures experiments which used the overall objectives (6.93) and treatment day objectives (5.12) pre- and posttest mean scores. These F-values were significant above the five percent level.

A stepwise regression analysis, using class means for each of the independent variables for the animal health unit, was calculated and the results are reported in Table 7. The step in which a variable entered the regression, the variable that entered and R^2's are shown. The first three variables to enter the regression analysis were used as covariates in

Table 7. Stepwise regression using specific objectives class means for each of the independent variables for the animal health unit

Step	Variable	R^2
1	Verbal aptitude	0.67
2	Number of older sisters	0.86
3	Number of younger brothers	0.94

an analysis of covariance. Snedecor (15) suggested that the best subset of three or four variables be used in multiple regression analysis unless additional variables contribute greatly to the accuracy of the experiment. The first three variables (verbal aptitude, number of older sisters and number of younger brothers) accounted for 94 percent of the variation in the data.

Ho_5: There were no differences between the specific objectives mean scores for the animal health posttest in the audio-tutorial and control schools when verbal aptitude, number of older sisters and number of younger brothers were used as covariates.

The independent variable means for verbal aptitude, number of older sisters and number of younger brothers are presented in Table 3. The unadjusted and adjusted mean scores for the treatment and control schools are presented in Table 8. An initial difference in posttest scores of 8.25 points was indicated between the audio-tutorial and control schools. A difference of 1.26 points was obtained when the specific objectives posttest scores were adjusted with respect to verbal aptitude, number of older

Table 8. Unadjusted and adjusted specific objectives means for animal health posttest when verbal aptitude, number of older sisters and number of younger brothers were used as covariates

Technique	Mean posttest scores	
	Unadjusted	Adjusted
Audio-tutorial	51.43	54.92
Control	59.68	56.18
Difference	8.25	1.26

sisters and number of younger brothers. An analysis of covariance was computed on the posttest scores and is reported in Table 9. A nonsignificant F-value of 0.38 was obtained and hypothesis Ho_5 was not rejected. There were no differences between the mean scores for the animal health posttest in the audio-tutorial and control schools when verbal aptitude, number of older sisters and number of younger brothers were used as covariates.

Table 9. Analysis of covariance for the animal health specific objectives posttest scores for the audio-tutorial and control schools when verbal aptitude, number of older sisters and number of younger brothers were used as covariates

		Residuals		
Source of variation	d.f.	S.S.	M.S.	F
Technique	1	2.34	2.34	0.38
Error	7	43.01	6.14	
Total	8	45.35		

Commercial Fertilizers

Overall mean scores for the dependent variable (posttest) and the 38 independent variables associated with instruction in commercial fertilizers are presented in Table 10. The mean scores for the audio-tutorial and control schools are shown. The means provided the information concerning the treatment effects which were then tested against the variations in the class means.

The mean pretest scores for items included under specific objectives reported in Table 10 reveal that the audio-tutorial schools had a mean score of 31.14, whereas, the control schools had a mean pretest score of 36.53. A single classification analysis of variance was calculated for the three methods of scoring the pretest and are reported in Table 10. The three methods of scoring the pretest-posttest were explained previously in the animal health section. The trend for the F-value to increase or decrease in magnitude is reported in Table 11 which includes the test results for the analysis of variance using the three scoring methods.

Ho_6: There were no differences between the specific objectives mean pretest scores of the audio-tutorial and control schools for the commercial fertilizer unit.

The determination of the acceptance or rejection of the null hypotheses involved only the use of specific objectives mean scores. The F-value obtained (2.48) indicated that the mean pretest scores for specific objectives items were not significantly different and hypothesis Ho_6 was not rejected. There were no differences between the mean pretest scores for specific objectives items of the audio-tutorial and control schools for the commercial fertilizer unit. In addition, the F-values associated with the

Table 10. Means for dependent and independent variables for the commercial fertilizer unit by instructional technique

Variable	Technique		Overall mean
	Audio-tutorial	Control	
Pretest - overall objectives	29.23	33.61	31.42
Pretest - treatment day objectives	29.97	36.38	33.18
Pretest - specific objectives	31.14	36.53	33.83
Posttest - overall objectives	38.72	48.27	43.49
Posttest - treatment day objectives	41.59	55.31	48.45
Posttest - specific objectives	44.13	52.09	48.12
Intelligence quotient	93.58	104.20	98.89
Mechanical aptitude	56.96	65.84	61.40
Abstract aptitude	50.41	73.44	61.93
Verbal aptitude	41.34	59.15	50.25
Agriculture achievement	33.62	62.14	47.88
Outdoor interest	67.89	74.01	70.95
Mechanical interest	49.37	57.12	53.24
Computational interest	44.12	47.68	45.90
Scientific interest	32.44	37.51	34.97
Persuasive interest	44.13	53.67	48.90
Artistic interest	39.56	48.99	44.27
Literary interest	45.68	48.38	47.03
Social service interest	41.85	40.98	41.41
Clerical interest	59.53	56.01	57.77
Student skill sheet	14.56	13.72	14.14
Crop acres	188.80	236.98	212.89
Noncrop acres	44.41	51.30	47.85
Total farm acres	232.97	289.79	261.27
Animal units	101.91	186.58	144.24
Number of older brothers	0.90	1.14	1.02
Number of younger brothers	0.62	0.67	0.64
Number of older sisters	1.14	0.97	1.05
Number of younger sisters	1.05	0.85	0.95
Total number of brothers and sisters	3.71	3.61	3.66
Semesters of science	2.58	2.75	2.66
Semesters of mathematics	2.27	2.98	2.62
Semesters of business	0.24	0.21	0.22
Semesters of vocational agriculture	3.28	3.62	3.45
Semesters of industrial arts	0.23	0.00	0.12
Teacher knowledge	33.83	33.50	33.67
Teacher personality	45.00	52.67	48.83
Class size	15.83	8.83	12.33
Department size	59.33	39.17	49.25
Teacher tenure	9.67	4.83	7.25
Teacher experience	13.33	6.83	10.08

Table 11. Analysis of variance on mean pretest scores for commercial fertilizers by overall, treatment day and specific objectives

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Overall objectives				
Treatment	1	57.86	57.86	2.13
Error	10	270.42	27.04	
Total	11	328.28		
Treatment day objectives				
Treatment	1	123.20	123.20	2.53
Error	10	486.11	48.61	
Total	11	609.31		
Specific objectives				
Treatment	1	87.22	87.22	2.48
Error	10	351.34	35.13	
Total	11	438.56		

overall (2.13) and treatment day objectives (2.53) mean pretest scores and reported in Table 4 were not significantly different.

Ho_7: There were no differences between the combined specific objectives mean pre- and posttest scores of the audio-tutorial and control schools for the commercial fertilizer unit.

Ho_8: There were no differences between the specific objectives mean pre- and posttest scores of the audio-tutorial and control schools for the commercial fertilizer unit.

Ho_9: There were no differences between the magnitude of change from the specific objectives mean pre- to posttest scores of the audio-tutorial and control schools for the commercial fertilizer unit.

The two-factor experiment using repeated measures, as explained in the animal health section of this chapter, was used to test the preceding three hypotheses. The results of the analysis of the two-factor experiment using the repeated measures of the specific objectives mean pre- and posttest scores are reported in Table 12. The nonsignificant F-value (1.80) supports the hypothesis Ho_7 that there were no differences between the combined specific objectives mean pre- and posttest scores of the audio-tutorial and control schools. Hypothesis Ho_7 was not rejected. Data presented reveal nonsignificant F-values for the overall objectives (2.53) and treatment day objectives (3.73) combined mean scores for the pre- and posttests.

Data in Table 13 indicate the specific objectives combined mean scores for the audio-tutorial (37.64) and control (44.31) differed by 6.67 points.

Hypothesis Ho_8 was rejected when a highly significant F-value (41.28) was obtained from the analysis of the specific objectives mean scores. Highly significant F-values were also reported in Table 12 for the overall objectives (43.33) and the treatment day objectives (51.06) mean scores. The mean posttest scores of the treatment and control schools were found to be different than the mean pretest scores of these schools. A significant amount of knowledge as measured by the pre- and posttests was gained during the experimental period.

The analysis of variance test for hypothesis Ho_9 provided a nonsignificant F-value (0.33) and the hypothesis was not rejected. There were no

Table 12. Analysis of two-factor experiments using the repeated measures of mean pre- and posttest scores by overall, treatment day and specific objectives for classes taught the commercial fertilizer unit

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Overall objectives				
Method	1	291.35	291.35	2.53
Error (a)	10	1151.11	115.11	
Time	1	874.10	874.10	43.33**
Method x time	1	39.83	39.83	1.97
Error (b)	10	201.72	20.17	
Total	23	2558.11		
Treatment day objectives				
Method	1	607.92	607.92	3.73
Error (a)	10	1630.66	163.07	
Time	1	1399.18	1399.18	51.06**
Method x time	1	80.26	80.26	2.93
Error (b)	10	274.02	27.40	
Total	23	3992.04		
Specific objectives				
Method	1	267.06	267.06	1.80
Error (a)	10	1483.51	148.35	
Time	1	1222.65	1222.65	41.28**
Method x time	1	9.83	9.83	0.33
Error (b)	10	296.19	29.62	
Total	23	3279.25		

**Significant above the one percent level.

Table 13. Combined mean pre- and posttest scores by specific objectives item scores of the audio-tutorial and control schools for the commercial fertilizer unit

Method	Pretest	Posttest	Total
Audio-tutorial	31.14	44.13	37.64
Control	36.53	52.08	44.31
Total	33.83	48.11	

differences between the magnitude of change from the specific objectives mean pre- to posttest scores of the audio-tutorial and control schools for the commercial fertilizer unit. Reported in Table 12 are the F-values for the above tests which used the overall objectives (1.97) and treatment day objectives (2.93) pre- and posttest mean scores. These F-values were not significant.

A stepwise regression analysis using class means for each of the independent variables for the commercial fertilizer unit was calculated and the results are reported in Table 14. The step in which a variable entered, the variable that entered and the R^2's are shown.

The first three variables to enter the regression analysis were used as covariates in an analysis of covariance. The first three variables (pretest, outdoor interest and number of older brothers) accounted for 90 percent of the variation in the data.

Ho_{10}: There were no differences between the specific objectives mean scores for the commercial fertilizer posttest in the audio-tutorial and control schools when pretest, outdoor interest and number of older brothers

Table 14. Stepwise regression using specific objectives class means for each of the independent variables for the commercial fertilizer unit

Step	Variable	R^2
1	Pretest	0.73
2	Outdoor interest	0.85
3	Number of older brothers	0.90

were used as covariates.

The specific objectives mean scores for pretest, outdoor interest and number of older brothers are reported in Table 10. Reported in Table 15 are the unadjusted and adjusted mean posttest scores for the treatment and control schools. An initial difference in posttest scores of 7.96 was indicated between the audio-tutorial and control schools.

A difference of 1.35 points in favor of the control group was obtained

Table 15. Unadjusted and adjusted specific objectives mean scores for commercial fertilizers when pretest, outdoor interest and number of older brothers were used as covariates

Technique	Mean posttest scores	
	Unadjusted	Adjusted
Audio-tutorial	44.13	48.18
Control	52.09	49.53
Difference	7.96	1.35

when the specific objectives posttest scores were adjusted with respect to pretest, outdoor interest and number of older brothers. An analysis of covariance was computed on these posttest scores and is reported in Table 16. A nonsignificant F-value of 0.00 was obtained and hypothesis Ho_{10} was not rejected. There were no differences between the mean scores for the commercial fertilizer posttest in the audio-tutorial and control schools when pretest, outdoor interest and number of older brothers were used as covariates.

Table 16. Analysis of covariance for the commercial fertilizers specific objectives posttest scores for the audio-tutorial and control schools when pretest, outdoor interest and number of older brothers were used as covariates

		Residuals		
Source of variation	d.f.	S.S.	M.S.	F
Technique	1	0.00	0.00	0.00
Error	7	167.57	23.94	
Total	8	167.57		

Small Gasoline Engines

The mean scores in the small gasoline engines area for the dependent variable (posttest) scored by the three methods used in the two preceding sections of the findings are presented in Table 17 together with the independent variables associated with instruction in small gasoline engines in the audio-tutorial and control schools. The overall mean scores are also reported. As mentioned previously, the means in Table 17 provided the

Table 17. Means for dependent and independent variables for the small gasoline engines unit by instructional technique

Variable	Technique		Overall mean
	Audio-tutorial	Control	
Pretest - overall objectives	44.93	38.42	41.68
Pretest - treatment day objectives	43.58	36.15	39.87
Pretest - specific objectives	42.62	35.10	38.86
Posttest - overall objectives	62.93	68.44	65.68
Posttest - treatment day objectives	64.85	69.03	66.94
Posttest - specific objectives	68.25	69.79	69.02
Intelligence quotient	99.09	104.73	101.91
Mechanical aptitude	56.91	51.14	54.03
Abstract aptitude	46.18	60.85	53.51
Verbal aptitude	43.27	52.61	47.94
Agriculture achievement	47.71	61.26	54.48
Outdoor interest	65.59	74.29	69.94
Mechanical interest	49.20	51.58	50.39
Computational interest	47.55	51.64	49.60
Scientific interest	32.74	31.42	32.08
Persuasive interest	45.97	58.75	52.36
Artistic interest	41.79	44.10	42.94
Literary interest	46.64	47.86	47.24
Social service interest	44.13	50.52	47.33
Clerical interest	59.72	56.90	58.31
Student skill sheet	36.50	21.87	29.19
Crop acres	164.86	267.93	216.39
Noncrop acres	38.64	58.63	48.63
Total farm acres	203.48	297.07	250.28
Animal units	96.73	249.93	173.33
Number of older brothers	0.80	0.79	0.79
Number of younger brothers	0.75	0.58	0.66
Number of older sisters	1.18	0.86	1.02
Number of younger sisters	1.05	0.76	0.90
Total number of brothers and sisters	3.79	2.96	3.38
Semesters of science	3.03	3.57	3.30
Semesters of mathematics	3.53	3.84	3.69
Semesters of business	0.80	0.73	0.77
Semesters of vocational agriculture	5.12	5.64	5.38
Semesters of industrial arts	0.76	0.40	0.58
Teacher knowledge	31.00	31.50	31.25
Teacher personality	21.67	52.67	37.17
Class size	14.33	9.67	12.00
Department size	59.33	39.17	49.25
Teacher tenure	9.67	4.83	7.25
Teacher experience	13.33	6.83	10.08

information concerning the treatment effects which were tested against the variations in the class means.

Ho_{11}: There were no differences between the specific objectives mean pretest scores of the audio-tutorial and control schools for the small gasoline engines unit.

As reported in Table 17, the audio-tutorial schools had a mean score of 42.62, whereas, the control schools had a mean pretest score by specific objectives of 35.10. The pretest scores were tested by a single classification analysis of variance for each of the three methods of scoring. The resulting F-values are reported in Table 18. The F-value for the specific objectives mean scores were used to determine the acceptance or rejection of the hypothesis Ho_{11}. The F-value obtained (2.31) revealed that the mean pretest scores by specific objectives were not significantly different and hypothesis Ho_{11} was not rejected. There were no differences between the mean pretest scores by specific objectives for the audio-tutorial and the control schools for the small gasoline engines unit. The F-values reported in Table 18 for the overall (2.32) and treatment day objectives (2.50) were not significantly different.

Ho_{12}: There were no differences between the combined specific objectives mean pre- and posttest scores of the audio-tutorial and control schools for the small gasoline engines unit.

Ho_{13}: There were no differences between the specific objectives mean pre- and posttest scores of the audio-tutorial and control schools for the small gasoline engines unit.

Ho_{14}: There were no differences between the magnitude of change from the specific objectives mean pre- and posttest scores of the audio-tutorial

Table 18. Analysis of variance on mean pretest scores for small gasoline engines unit by overall, treatment day and specific objectives

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Overall objectives				
Treatment	1	126.89	126.89	2.32
Error	10	546.93	54.69	
Total	11	673.81		
Treatment day objectives				
Treatment	1	165.91	165.91	2.50
Error	10	663.07	66.31	
Total	11	828.98		
Specific objectives				
Treatment	1	169.43	169.43	2.31
Error	10	733.26	73.33	
Total	11	902.70		

and control schools for the small gasoline engines unit.

The two-factor experiment, as used previously for the animal health and commercial fertilizer analyses, was again used to test the preceding three hypotheses. Reported in Table 19 are the results of the analysis of the two-factor experiment using the repeated measures of pre- and posttest scores. The nonsignificant F-value (1.75) supports hypothesis Ho_{12} that there were no differences between the combined specific objectives mean pre- and posttest scores of the audio-tutorial and control schools. Hy-

Table 19. Analysis of two-factor experiments using the repeated measures of mean pre- and posttest scores by overall, treatment day and specific objectives for classes taught the small gasoline engines unit

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Overall objectives				
Method	1	1.46	1.46	0.02
Error (a)	10	654.39	65.44	
Time	1	3458.39	3458.39	169.79**
Method x time	1	216.72	216.72	10.64**
Error (b)	10	203.69	20.37	
Total	23	4534.65		
Treatment day objectives				
Method	1	15.99	15.99	0.20
Error (a)	10	734.05	73.40	
Time	1	4398.05	4398.05	154.97**
Method x time	1	202.13	202.13	7.12*
Error (b)	10	283.79	28.38	
Total	23	5634.02		
Specific objectives				
Method	1	53.61	53.61	0.59
Error (a)	10	905.11	90.51	
Time	1	5457.43	5457.43	178.37**
Method x time	1	122.90	122.90	4.02
Error (b)	10	305.95	30.60	
Total	23	6845.00		

**Significant above the one percent level.

*Significant above the five percent level.

pothesis Ho_{12} was not rejected. The overall objectives (0.07) and treatment day objectives (0.56) combined mean scores for the pre- and posttest indicated nonsignificant F-values as reported in Table 19. The audio-tutorial (55.44) and control school (52.45) specific objectives combined mean scores differed by 2.99 points as revealed by data in Table 20.

Table 20. Combined mean pre- and posttest by specific objectives scores of the audio-tutorial and control schools for the small gasoline engines unit

Method	Pretest	Posttest	Total
Audio-tutorial	42.62	68.25	55.44
Control	35.10	69.69	52.45
Total	38.86	69.02	

A highly significant F-value (178.37) was obtained from the analysis of the specific objectives mean scores and is reported in Table 19. Hypothesis Ho_{14} was rejected. The mean posttest scores of the treatment and control schools were found to be different than the mean pretest scores of these schools. A significant amount of knowledge as measured by the pre- and posttests was gained during the experimental period. Highly significant F-values were also indicated in Table 19 for the overall objectives (169.79) and the treatment day objectives (154.97) mean scores.

A nonsignificant F-value (4.02) was obtained from the analysis of variance test for hypothesis Ho_{14}. Hypothesis Ho_{14} was not rejected. There were no differences between the magnitude of change from the specific

objectives pre- to posttest scores of the audio-tutorial and control schools for the small gasoline engines unit.

A highly significant F-value (10.64) was obtained for the overall objectives mean scores, whereas, a significant F-value (7.12) was indicated when the treatment day objectives pre- and posttest scores were analyzed using the repeated measures technique.

The class means were again used in a stepwise regression analysis which used each of the independent variables. The data are presented in Table 17. An analysis of covariance was completed which contained the first three variables that entered the stepwise regression equation.

The steps in which the three variables entered the regression, identification of the variable and the R^2's are reported in Table 21. The first three variables (social service interest, mechanical aptitude and scientific aptitude) accounted for 86 percent of the variation in the data.

Ho_{15}: There were no differences between the specific objectives mean scores for the small gasoline engines posttest in the audio-tutorial and control schools when social service interest, mechanical aptitude and

Table 21. Stepwise regression using specific objectives class means for each of the independent variables for the small gasoline engines unit

Step	Variable	R^2
1	Social service interest	0.39
2	Mechanical aptitude	0.75
3	Scientific interest	0.86

scientific interest were used as covariates.

The social service interest, mechanical aptitude and scientific interest independent variable means are presented in Table 17. The unadjusted and adjusted mean scores for the treatment and control schools are indicated in Table 22. An initial difference in posttest scores of 1.54 points was reported between the audio-tutorial and control schools. After adjustment, with respect to social service interest, mechanical aptitude and scientific aptitude, a difference of 6.05 points was revealed between the specific objectives posttest mean scores for the audio-tutorial and control schools.

Table 22. Unadjusted and adjusted specific objectives means for small gasoline engines when social service interest, mechanical aptitude and scientific aptitude were used as covariates

Technique	Mean posttest scores	
	Unadjusted	Adjusted
Audio-tutorial	68.25	72.19
Control	69.79	66.14
Difference	1.54	6.05

An analysis of covariance was computed on the posttest scores and is reported in Table 23. A F-value (5.57) closely approaching significance at the five percent level (5.59) was obtained. However, hypothesis Ho_{15} was not rejected. There were no differences between the mean scores for the small gasoline engines posttest in the audio-tutorial and control schools when social service interest, mechanical aptitude and scientific interest

Table 23. Analysis of covariance for the small gasoline engines specific objectives posttest scores for the audio-tutorial and control schools when social service interest, mechanical aptitude and scientific aptitude were used as covariates

	Residuals			
Source of variation	d.f.	S.S.	M.S.	F
Technique	1	29.40	29.40	5.57
Error	7	36.95	5.28	
Total	8	66.35		

were used as covariates.

Farm Credit

The means for the dependent variable (posttest) scored by the three methods, and the overall mean scores, are presented in Table 24 together with the 38 independent variables associated with instruction in farm credit in the audio-tutorial and control schools. The information concerning the treatment effects provided by the means in Table 24 was used in testing variations in the class means.

Ho_{16}: There were no differences between the specific objectives mean pretest scores of the audio-tutorial and control schools for the farm credit unit.

The data reported reveal that the audio-tutorial schools had a specific objectives mean pretest score of 43.06, whereas, the control schools had a mean score of 49.02. The three methods of scoring the pretest were statistically treated by using a single classification analysis of variance.

Table 24. Means for dependent and independent variables of the farm credit unit by instructional technique

Variables	Technique		Overall mean
	Audio-tutorial	Control	
Pretest - overall objectives	40.65	48.39	44.52
Pretest - treatment day objectives	44.21	51.61	47.91
Pretest - specific objectives	43.06	49.02	46.04
Posttest - overall objectives	55.07	64.44	59.76
Posttest - treatment day objectives	58.33	69.51	63.93
Posttest - specific objectives	58.83	68.47	63.65
Intelligence quotient	99.36	104.77	102.06
Mechanical aptitude	44.84	52.37	48.60
Abstract aptitude	44.63	62.26	53.45
Verbal aptitude	37.56	45.47	41.52
Agriculture achievement	45.49	69.36	57.42
Outdoor interest	63.22	75.21	59.22
Mechanical interest	48.76	65.08	56.92
Computational interest	40.24	53.31	46.78
Scientific interest	28.21	41.57	34.89
Persuasive interest	48.27	50.09	49.18
Artistic interest	43.47	42.11	42.79
Literary interest	42.30	34.70	38.50
Social service interest	45.83	48.05	46.95
Clerical interest	52.67	59.87	56.27
Student skill sheet	20.35	30.73	25.55
Crop acres	191.40	259.49	225.44
Noncrop acres	55.44	49.72	52.58
Total farm acres	30.18	309.21	269.69
Animal units	108.94	158.24	133.59
Number of older brothers	0.74	0.71	0.73
Number of younger brothers	0.64	0.54	0.60
Number of older sisters	1.02	1.13	1.08
Number of younger sisters	1.07	0.85	0.96
Total number of brothers and sisters	3.49	3.18	3.33
Semesters of science	3.45	3.64	3.54
Semesters of mathematics	3.71	4.55	4.13
Semesters of business	1.29	1.64	1.46
Semesters of vocational agriculture	7.01	7.19	7.10
Semesters of industrial arts	0.88	0.75	0.82
Teacher knowledge	31.83	29.33	30.58
Teacher personality	57.00	52.67	54.83
Class size	13.50	9.17	11.33
Department size	59.33	39.17	49.25
Teacher tenure	9.67	4.83	7.25
Teacher experience	13.33	6.83	10.08

The three F-values obtained are reported in Table 25 to indicate trends in the values to increase or decrease in magnitude. As mentioned previously, only the F-value for the specific objectives mean scores was used to determine the acceptance or rejection of the null hypotheses. The F-value obtained (0.81) revealed that the mean pretest scores by Winer (23) cautioned that the differences between the pre- and posttest means would be confounded in considering the effects tested in Ho_{17}. Hypothesis Ho_{17} was not rejected. Data presented in Table 26 reveal nonsignificant F-values for the overall objectives (2.11), and for the treatment day objectives (1.85)

Table 25. Analysis of variance on mean pretest scores for farm credit unit by overall, treatment day and specific objectives

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Overall objectives				
Treatment	1	179.73	179.73	1.26
Error	10	1424.77	142.48	
Total	11	1604.50		
Treatment day objectives				
Treatment	1	164.34	164.34	0.83
Error	10	1975.78	197.58	
Total	11	2140.11		
Specific objectives				
Treatment	1	106.74	106.74	0.81
Error	10	1321.04	132.10	
Total	11	1427.77		

Table 26. Analysis of two-factor experiments using the repeated measures of mean pre- and posttest scores by overall, treatment day and specific objectives for classes taught the farm credit unit

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Overall objectives				
Method	1	439.21	439.21	2.11
Error (a)	10	2078.99	207.90	
Time	1	1392.47	1392.47	35.25**
Method x time	1	3.99	3.99	0.10
Error (b)	10	395.01	39.50	
Total	23	4309.68		
Treatment day objectives				
Method	1	518.00	518.00	1.85
Error (a)	10	2806.66	280.66	
Time	1	1539.19	1539.19	35.53**
Method x time	1	21.43	21.43	0.49
Error (b)	10	433.18	43.32	
Total	23	5318.47		
Specific objectives				
Method	1	365.04	365.04	1.74
Error (a)	10	2097.44	209.74	
Time	1	1860.66	1860.66	56.16**
Method x time	1	20.20	20.20	0.61
Error (b)	10	331.30	33.13	
Total	23	4674.64		

**Significant above the one percent level.

*Significant above the five percent level.

combined mean scores for the pre- and posttests. Data in Table 27 reveal that the specific objectives combined mean scores for the audio-tutorial (50.95) and control schools (58.75) differed by 7.80 points.

A highly significant F-value (56.16) was obtained when hypothesis Ho_{18} was tested and the null hypothesis was rejected. Highly significant F-values were also revealed in Table 26 for the overall objectives (35.25)

Table 27. Combined mean pre- and posttest scores by specific objectives of the audio-tutorial and control schools for the farm credit unit

Method	Pretest	Posttest	Total
Audio-tutorial	43.06	58.83	50.95
Control	49.02	68.47	58.75
Total	46.04	63.65	

and for the treatment day objectives (35.53) mean scores. The mean posttest scores for the audio-tutorial and control schools were found to be different than the mean pretest scores of these schools. A significant amount of knowledge as measured by the pre- and posttests was gained during the experimental period.

The analysis of variance test for hypothesis Ho_{19} provided a nonsignificant F-value (0.61) and the hypothesis was not rejected. There were no differences between the magnitude of change from the specific objectives were not significantly different and hypothesis Ho_{16} was not rejected. There were no differences between the mean pretest scores for specific objectives items in the farm credit unit in the audio-tutorial and control

schools.

The F-values obtained for the overall (1.26) and the treatment day objectives (0.83) mean pretest scores and reported in Table 25 were not significantly different.

Ho_{17}: There were no differences between the combined specific objectives mean pre- and posttest scores of the audio-tutorial and control schools for the farm credit unit.

Ho_{18}: There were no differences between the specific objectives mean pre- and posttest scores of the audio-tutorial and control schools for the farm credit unit.

Ho_{19}: There were no differences between the magnitude of change from the specific objectives mean pre- to posttest scores of the audio-tutorial and control schools for the farm credit unit.

The two-factor experiment as described in the animal health section, was used to test Ho_{17}, Ho_{18}, and Ho_{19}. The results of the two-factor experiment are presented in Table 26. The nonsignificant F-value (1.74) supports the hypothesis Ho_{17} that there were no differences between the combined specific objectives mean pre- and posttest scores of the two groups of schools. However, specific objectives pre- to posttest scores of the audio-tutorial and control schools for the farm credit unit are confounded as previously mentioned. Reported in Table 26 are the F-values for the repeated measures experiment in which the overall objectives (0.10) and treatment day objectives (0.49) pre- and posttest scores were used. These F-values were nonsignificant at the five percent level.

A stepwise regression analysis using class means for each of the independent variables for the farm credit unit was performed and the results

are reported in Table 28. The step in which a variable entered, the variable that entered and R^2's are shown.

The first three variables (verbal aptitude, teacher experience and artistic interest) to enter the regression equation accounted for 96 percent of the variation in the data.

Table 28. Stepwise regression using specific objectives class means for each of the independent variables for the farm credit unit

Step	Variable	R^2
1	Verbal aptitude	0.77
2	Teacher experience	0.89
3	Artistic interest	0.96

Ho_{20}: There were no differences between the specific objectives mean scores for the farm credit posttest in the audio-tutorial and control schools when verbal aptitude, teacher experience and artistic interest were used as covariates.

The specific objectives mean scores for verbal aptitude, teacher experience and artistic interest are reported in Table 24. The unadjusted and adjusted mean posttest scores for the treatment and control schools are presented in Table 29. An initial difference in posttest scores of 9.64 points was indicated in favor of the control schools.

A difference of 3.39 points in favor of the audio-tutorial schools was obtained when the specific objectives posttest scores were adjusted with respect to verbal aptitude, teacher experience and artistic interest. An

Table 29. Unadjusted and adjusted specific objectives means for farm credit unit when verbal aptitude, teacher experience and artistic interest were used as covariates

Technique	Mean posttest scores	
	Unadjusted	Adjusted
Audio-tutorial	58.83	65.35
Control	68.47	61.96
Difference	9.64	3.39

analysis of covariance was computed on these posttest scores and is reported in Table 30. An F-value significant above the five percent level was obtained and hypothesis Ho_{20} was rejected. There were differences between the mean scores for the farm credit posttest in favor of the audio-tutorial schools when verbal aptitude, teacher experience and artistic interest were used as covariates.

Table 30. Analysis of covariance for the farm credit specific objectives posttest scores for the audio-tutorial and control schools when verbal aptitude, teacher experience and artistic interest were used as covariates

	Residuals			
Source of variation	d.f.	S.S.	M.S.	F
Technique	1	28.33	28.83	6.13*
Error	7	32.92	4.70	
Total	8	61.75		

*Significant above the five percent level.

DISCUSSION

Teachers of vocational agriculture need to use a variety of methods, media and materials to effectively teach vocational agriculture. They have traditionally used demonstrations, field trips, audio-visual media, individual student projects and many other methods. A rapid increase in the production of technical innovations for use in the teaching field has made crucial the need for an evaluation of their effectiveness in aiding the teacher to be more efficient in providing instruction.

The findings in this study indicated that the audio-tutorial technique developed for testing in this experiment was an effective media in assisting teachers of high school vocational agriculture.

The findings indicated nonsignificant differences in prior knowledge of the subject matter possessed by the students in the two groups of schools. This assumption was made after the results of subject matter pretests in the four areas were analyzed using an analysis of variance technique.

The audio-tutorial programs used in this experiment were developed by the researcher without the direct help of professional and commercial programmers of audio-tutorial materials. Few teachers of vocational agriculture have departmental budgets of monetary size necessary to purchase an extensive library of audio-tutorial programs. In addition, the author found few audio-tutorial programs available commercially. However, many types of audio-tutorial equipment are available. Most teachers of vocational agriculture do have access to tape-recorders and 35 mm slide projectors. Slide tape synchronizers for use with standard tape-recorders and

slide projectors are marketed by most audio-visual suppliers. It is the opinion of the author that the audio-tutorial programs employed in this study could be prepared by most teachers of agriculture after a short training period in audio-tutorial program production techniques.

The effectiveness of the specific audio-tutorial technique studied as an aid in the teaching process was determined in part through the use of a two-factor repeated measures statistical technique. In all four areas of instruction (animal health, commercial fertilizers, small gasoline engines and farm credit) there were no significant differences between the mean pre- and posttest scores of the audio-tutorial and the control schools. The magnitude of change in the mean pre- to posttest scores in each of the four classes in the audio-tutorial and the control schools was not found to be significantly different.

In addition, the two-factor repeated measures experiment was used to analyze the combined mean scores for the pre- and posttest differences related to the audio-tutorial and control techniques. No significant differences were observed for the four classes. However, the pre- and posttest mean scores were confounded with the magnitude of change and large differences would have been required to indicate significance.

The author concluded at this point in the investigation that the audio-tutorial technique used in this experiment was as effective as the control technique in the teaching of vocational agriculture. Class mean scores representing each of the schools in the experiment were used as observations in the statistical treatments conducted in the analysis of data.

The six schools assigned to the audio-tutorial and the control groups were randomly selected from a larger sample of schools and represented the

random element in the experiment. An extreme observation representing one of the six schools could cause the results of the statistical analysis to be unrealistic. As a result of the statistical analyses of the pretest mean score differences, the findings permitted the author to assume that the four classes representing the two groups were not significantly different in subject matter knowledge prior to the experimental period. The random drawing of the audio-tutorial and the control schools had introduced a random element into the experiment.

Background information on the students and teachers was collected prior to the experimental period and included data on 38 different variables. A difference between the audio-tutorial and the control groups in mean scores was observed for many of the variables. The 38 variables were entered in a stepwise regression analysis as possible independent variables to be used in an analysis of covariance. The first three variables to enter the regression equation were used as covariates in the analysis of covariance.

Several assumptions are necessary in using an analysis of covariance technique to adjust posttest mean score differences. Winer (23) suggests that usual assumptions associated with an analysis of variance are appropriate with the analysis of covariance. In addition, the treatment and regression effects must be additive.

The author (23, p. 586) also stated:

> Evidence from the usual analysis of variance indicates that F tests in the analysis of covariance are robust with respect to the violation of the two assumptions, normality and homogeneity of the residual variance.

An inspection of the school means which made up the audio-tutorial and

the control schools independent variable mean scores revealed some trends toward nonnormality. The author concluded that erratic appearing observations should be expected due to the small number (six) of observations in each experimental group. The teachers in the audio-tutorial group were older and had more teaching experience, whereas, the control group was represented by younger, less experienced teachers. The researcher tentatively concluded that some of the tendency toward nonnormality among the independent variables was associated with the differences in teaching experience of the teachers comprising the two groups. The above tentative conclusion assumes that younger teachers tend to be more aggressive and that this aggressiveness tends to diminish in intensity as teaching experience increases. The use of the stepwise regression analysis accounted for not less than 86 percent of the variation in the data in each of the four classes analyzed.

The independent variables used as covariates in adjusting the posttest scores in animal health were (1) verbal aptitude, (2) number of older sisters and (3) number of younger brothers. All three of these variables were associated with an upward adjustment of the mean posttest scores for the audio-tutorial and a downward adjustment of the mean posttest scores for the control schools. A nonsignificant finding resulted from the above procedure. The audio-tutorial technique was assumed to be as effective as the control technique in teaching selected animal health subject matter. The unadjusted mean posttest scores were 51.43 for the audio-tutorial and 59.68 for the control group. After adjustment the mean scores were 54.92 for the audio-tutorial and 56.18 for the control group. The difference between posttest scores for the two groups was 1.26 points with the control group

receiving the higher mean score.

The verbal aptitude of the students should be considered in selecting the appropriate material for teaching animal health. The older son in the family with fewer older sisters tended to achieve better in the animal health area. Possibly the interaction of the older boy with the father and with younger brothers may increase his understandings in the animal health area. An animal production project might be of increased instructional value to the younger boy in a family of boys or to a boy with several older sisters.

The pretest, outdoor interest and number of older brothers were the independent variables used in adjusting the mean posttest scores for the audio-tutorial and the control group for the commercial fertilizer unit. The pretest and outdoor interest independent variable differences resulted in an upward adjustment of the mean posttest score for the audio-tutorial group. The number of older brothers was associated with a downward adjustment in the audio-tutorial mean posttest score.

The unadjusted mean posttest scores were 44.13 for the audio-tutorial and 52.09 for the control group. After adjustment the mean posttest score associated with the audio-tutorial group had moved upward to 48.18 and the mean posttest score for the control group moved downward to 49.53. A difference in mean scores of 1.35 points was indicated in favor of the control group.

A nonsignificant finding resulted from the analysis of covariance. The audio-tutorial group achieved as well in the commercial fertilizer subject matter area as the control group.

In preparing the teaching plan for the commercial fertilizer area the

teacher should consider the prior knowledge and outdoor interests of the students. The findings indicate that the boy with several older brothers might benefit from an activity on the home farm involving the use of commercial fertilizers. Farm visits to help the student initiate a project in the fertilizer area might improve his ability to achieve in this area.

In the analysis of covariance for the small gasoline engine subject matter area the independent variables of social service interest, mechanical interest and scientific interest were used as covariates.

The adjustment of the differences between the independent variable mean scores resulted in an upward adjustment of the audio-tutorial mean posttest score. All three of the variables contributed to the upward adjustment. Both mechanical interest and scientific interest can be easily accepted as related to student achievement in the small gasoline engines subject matter area. Social service interest might be partially explained when the uses of small gasoline engines and the occupational opportunities for using or repairing small gasoline engines are examined. The mowing of lawns and a natural affinity for engines by teenage boys might be one tentative explanation. Both of the preceding undertakings could involve contact with the general public. The mechanical and scientific interests of students should be used by teachers in planning programs in the small gasoline engines area.

The analysis of covariance resulted in findings closely approaching significance at the five percent level for the audio-tutorial technique. The audio-tutorial technique was assumed to be as effective as the control technique in helping students achieve understanding in the small gasoline engines area. An adjustment from 68.25 to 72.19 was observed in the mean

posttest scores for the audio-tutorial group and from 69.79 to 66.14 in mean posttest scores for the control group. A difference of 6.05 points was observed in favor of the audio-tutorial group.

The farm credit mean posttest scores were adjusted by analysis of covariance using verbal aptitude, teacher experience and artistic interest as covariates. The three covariates each caused some upward adjustment in the mean posttest score for the audio-tutorial group. Verbal aptitude of the students should be considered in preparing teaching programs in the farm credit area.

The independent variable of teacher experience was a primary contributor to the upward adjustment of the mean posttest score for the audio-tutorial group. The students in classes taught by teachers with less teaching experience achieved better than students in classes taught by older, more experienced teachers. The need for in-service education for older, more experienced teachers may be indicated to permit them to update subject matter and acquire new methods. However, the more experienced teachers in the audio-tutorial group may have been at a disadvantage due to their inability to use any of the other techniques being tested in the study.

A significant finding resulted from the analysis of covariance for the farm credit mean scores. A value significant above the five percent level for the audio-tutorial group was obtained. The audio-tutorial technique was found to be more effective than the control technique in teaching selected farm credit subject matter. Adjustment of the mean posttest scores changed the means for the audio-tutorial group from 58.83 to 65.35 and for the control group from 68.47 to 61.96. These changes in mean scores result

in a difference of 3.39 points in favor of control.

Greater precision could be obtained in future replications of this experiment by the introduction of more randomness in the model. The random assignment of students to the treatment and control groups would aid in reducing the experimental error. Experiments in audio-tutorial techniques are costly due to equipment, programming and teacher training expenses. The research costs limit the number of observations included in this type of experiment. The use of individual student scores rather than class means for statistical analysis would increase the efficiency of the data.

A random sample of teachers stratified by (1) years of teaching experience, (2) teacher tenure, (3) subject matter knowledge and (4) geographical location of the vocational agriculture departments could be used to reduce error. This would increase the chance of assuring normality in the variables associated with the treatment and control groups.

The use of students in classes within the randomly selected departments for random assignment to a treatment or control group could be accomplished by dividing the classes into two sections. The two class sections would be designated as either a treatment or control group.

More thorough training of the teachers prior to the start of the experiment would be of prime importance to the success of the study. At least one year should be used to develop materials, train the teachers and pretest both the materials and equipment. Audio-tutorial programs involving laboratory activities should be developed to supplement the programs used to transmit factual information. The use of different types of programs would increase student activity and bring more realism into the learning situation.

The audio-tutorial equipment used in this experiment experienced several functional failures. At three school locations at least one of the two machines available was inoperational for several days. The slide tape synchronizing capability in several of the machines failed. This resulted in the students manually advancing the slides as required by the taped programs. This failure was traced to the same electronic component in each machine that failed and was readily repaired. The distance from the schools to the service center resulted in several days delay. Damage to the equipment due to student vandalism was not observed by the author. Quite to the contrary, the students were reported to accept as a challenge the learning of the skills needed to operate the equipment efficiently.

The individual study stations were not uniformly provided by the six audio-tutorial schools. Three of the six schools made available suitable station areas and three schools did not due to lack of space or the distance from the vocational agriculture building to the main school. The lack of study stations did not allow the use of the audio-tutorial technique by many students in review and individual study situations.

In summary, the following points should be reviewed:

1. The audio-tutorial technique tested in this study was as effective as the control technique in teaching selected areas in animal health, commercial fertilizers and small gasoline engines.
2. The achievement of students taught by teachers incorporating the audio-tutorial technique into their instructional programs in the farm credit area was greater than that of students taught by teachers using the control technique.
3. Laboratory activities were not used in testing the audio-tutorial

technique. Only factual information was transmitted by the technique. The effectiveness of programming selected laboratory activities should be studied.

4. The effectiveness of a good teacher may be enhanced through the use of the audio-tutorial technique. However, the students taught by the control group teachers gained a significant amount of knowledge during the experimental period.
5. The provision for individual study station spaces should be included in future experiments using this audio-tutorial technique.
6. A close working relationship between the teacher of vocational agriculture and the guidance counselor should be established to allow the fullest use of background information about students in planning programs of vocational agriculture.
7. Future replications of this study should use the student scores as the basic observations for statistical analysis. The random assignment of students to a treatment or control section within a high school class could increase the precision of the experiment.
8. The contribution of an effective teacher to student achievement was once again demonstrated by the findings of this study.

SUMMARY

The audio-tutorial technique tested in this study constituted one part of a larger study designed to test the effectiveness of seven treatment techniques and a control in the teaching of selected subject matter in vocational agriculture. The studies were basically funded by a research grant obtained from the Iowa Department of Public Instruction, Division of Vocational Education from Ancillary funds provided by the Vocational Education Act of 1963. From a randomly drawn sample of 48 schools that met certain criteria six schools were randomly assigned to each treatment and control group.

A subject matter area was selected for each of the four grade levels in vocational agriculture by the project staff. The areas selected were: (1) animal health, (2) commercial fertilizers, (3) small gasoline engines and (4) farm credit. A 14-day teaching outline (Appendix A) was developed which included the daily teaching objectives, reference materials and reading assignments. The same reference material and teaching outline were provided to all 12 schools participating in the experiment. The treatment schools used the audio-tutorial technique in their instructional program and could not use any of the other media that were tested in the larger study. The control schools were not permitted to use audio-tutorial techniques, or any of the other six techniques that were tested in the study.

Audio-tutorial machines were used in the study which offered a two-track tape, synchronizing capability, circular storage of 80 slides and a student controlled start-stop control. Four audio-tutorial programs of a maximum length in minutes of 20 were prepared for each of the four subject

matter areas by the author.

The instructors were acquainted with the experimental program and the audio-tutorial technique at two meetings prior to the start of the experiment. Visits were made to the treatment and control schools during the experimental period by members of the project staff and the researcher.

The effects of certain home, student, teacher and school characteristics on student achievement were also considered in the investigation. Information about the students was collected by the school counselors. They administered the following data:

1. Otis Quick-Scoring Mental Ability,
2. Kuder General Interest Survey (Form E),
3. Nebraska Agriculture Achievement,
4. Differential Aptitude Test - Mechanical Section,
5. Differential Aptitude Test - Abstract Section, and
6. Differential Aptitude Test - Verbal Section.

A 60-item test over each subject matter area was used both as the pretest and posttest and was administered by the school counselor.

The socio-economic background information on the students was collected by questionnaire. The Minnesota Teacher Attitude Inventory and a pretest and posttest on teacher knowledge was completed by each of the participating teachers. The latter were studied in depth by Beane (1). Additional information collected on the teacher included years of tenure at present school, total years of teaching and educational level.

Statistical methods used in analyzing the data included analysis of variance, analysis of covariance, a two-factor experiment with repeated measures and stepwise regression.

The specific objectives mean scores used in the statistical analysis were composed of questions from the pre- and posttests that tested the specific audio-tutorial program objectives. A single classification analysis of variance was calculated for each of the class levels for the pretest mean scores to determine the presence of differences between the group mean scores prior to the start of the experimental period. There were no significant differences observed between the pretest scores for the audio-tutorial and the control groups. It was assumed that the two groups were equal in subject matter knowledge prior to the experiment.

A two-factor experiment using repeated measures was used to test for differences between the combined specific objectives mean scores of the audio-tutorial and the control schools for each of the four classes. No significant differences were observed and it was assumed there were no differences in achievement by the four classes when taught using the audio-tutorial or the control techniques.

The possibility of differences between specific objectives mean pre- and posttest scores of the audio-tutorial and the control schools for each of the four classes was tested by using the two-factor experiment. Highly significant differences were reported for each of the four classes. There was a highly significant amount of knowledge gained by each of the four classes in both the audio-tutorial and the control groups.

The two-factor experiment with repeated measures was used to detect any differences between the magnitude of change from the specific objectives mean pre- to posttest scores of the audio-tutorial and the control schools for each of the four classes. No significant differences were observed and it was assumed that the magnitude of change from pre- to post-

test was similar for the audio-tutorial and the control schools.

A stepwise regression analysis using class means for each of the independent variables for the four classes was used to select the best subset of three variables to use with an analysis of covariance. The stepwise regression analysis selected covariates for use with each of the four class analyses which accounted for 86 percent or more of the variance in the data for each class.

Verbal aptitude, number of older sisters and number of younger brothers were selected as the subset of independent variables for use with analysis of covariance in the animal health area. There were no differences between the specific objectives mean scores for the animal health posttest for the audio-tutorial and the control scores when the three independent variables were used as covariates. The adjusted mean score for the control schools was 1.26 points higher than the scores for the audio-tutorial schools.

The analysis of covariance in the commercial fertilizer area indicated that there were no differences between the specific objectives mean scores for the commercial fertilizer posttest in the audio-tutorial and control schools when pretest, outdoor interest and number of older brothers were used as covariates. A difference of 1.35 points in favor of the control schools was obtained after the mean scores were adjusted for the differences represented by the three independent variables.

In the small gasoline engine area the students' social service interest, mechanical interest and scientific interest independent variable mean scores were used as covariates in an analysis of covariance. A value closely approaching significance at the five percent level was obtained.

However, it was assumed that there were no differences between adjusted specific objective mean scores for the two groups of schools. A difference in mean scores of 6.05 points in favor of the audio-tutorial group was observed.

The first three independent variables to enter the stepwise regression equation analysis for the farm credit area were verbal aptitude, teacher experience and artistic interest. An analysis of covariance using the three variables yielded a F-value that was significant above the five percent level. The audio-tutorial technique was assumed to be significantly more effective than the control technique in teaching selected areas of farm credit subject matter.

The results of this study could be condensed into the following summary statements:

1. The students in the audio-tutorial and the control schools were nearly equal in prior knowledge of the subject matter before the 14-day instructional period began.
2. Statistical analyses used to reveal differences between the audio-tutorial and the control schools in magnitude of change in knowledge from the pretest to the posttest yielded nonsignificant values for each of the four class level comparisons.
3. The use of statistical techniques to adjust for differences in the posttest mean scores due to prior differences in the independent variable mean scores resulted in a significant value associated with the adjusted mean scores for the audio-tutorial technique effectiveness in teaching farm credit. The audio-tutorial technique was as effective as the control technique in teaching animal

health, commercial fertilizer and small gasoline engines.

This study has demonstrated the effectiveness of an audio-tutorial technique in teaching selected subject matter areas in vocational agriculture.

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APPENDIX

ANIMAL HEALTH

ANIMAL HEALTH

Problem Area Outline by Days

Day	
1	The Economic Importance of Livestock Diseases and Parasites
2	Factors in Maintaining Animal Health
3 & 4	Causes, Symptoms, Prevention and Control of Major Cattle Diseases
5	Life Cycles, Symptoms, Prevention and Control of Major Cattle Parasites
6 & 7	Causes, Symptoms, Prevention and Control of Major sheep Diseases
8	Life Cycles, Symptoms, Prevention and Control of Major Sheep Parasites
9 & 10	Casues, Symptoms, Prevention and Control of Major Swine Diseases
11	Life Cycles, Symptoms, Prevention and Control of Major Swine Parasites
12	Planning a General Livestock Health Program
13	Occupational Roles of the Veterinarian, Farmer, and Other Animal Health Workers
14	Summary and Review
15	Post-Test

ANIMAL HEALTH

Behavioral Objectives: (understandings and abilities)

Understanding of:

1) The relation between control of diseases and parasites with efficient production of livestock

2) The types, causes, symptoms, prevention and control of the major diseases and parasites of livestock

3) The occupational roles of the veterinarian, farmer, and other animal health workers

4) The possibilities for employment in occupations requiring a knowledge of animal diseases and parasites

Ability to:

1) Recognize normal and abnormal health conditions prevalent in livestock and livestock production

2) Plan an effective program for controlling livestock diseases and parasites

3) Maintain desirable animal health conditions for livestock

ANIMAL HEALTH

Day 1

1. PROBLEM AREA: The Economic Importance of Livestock Diseases and Parasites

Objectives:

To develop an understanding of:

a. The importance of livestock diseases and parasites upon profitable livestock production
b. The amount of damage done to livestock and livestock products by diseases and parasites
c. The cost of controlling livestock diseases and parasites

References:

a. Animal Health, Ch. 1, pp. 1-6
b. Animal Health Handbook, pp. 2-3

Day 2

2. PROBLEM AREA: Factors in Maintaining Normal Animal Health

Objectives:

To develop an understanding of:

a. The physical characteristics of the healthy animal
b. Characteristics that indicate abnormal health and behavior of animals
c. Proper management steps in preventing and controlling livestock diseases and parasites
d. Desirable livestock health conditions

To develop an ability to:

a. Recognize normal and abnormal livestock and livestock conditions
b. Determine when an animal needs medical attention

References:

a. Animal Health, Ch. 2, pp. 7-12
b. Animal Health Handbook, pp. 43-45, 49-50, 87-90, 93-95, 105-106, 109-110

ANIMAL HEALTH

Days 3 and 4

3. PROBLEM AREA: Causes, Symptoms, Prevention, and Control of Major Cattle Diseases

Objectives:

To develop an understanding of:

a. The types of cattle diseases
b. Causes, symptoms, treatment, and prevention of the following diseases of cattle:

1. Brucellosis
2. Shipping Fever Complex
3. Foot Rot
4. Pinkeye
5. Ringworm
6. Mastitis
7. Leptospirosis
8. Calf Scours
9. Warts
10. Pneumonia
11. Milk Fever
12. Ketosis
13. Bloat

To develop an ability to recognize conditions of cattle that warrant calling a veterinarian

References:

a. Animal Health, Ch. 3, pp. 13-17; Ch. 4, pp. 18-29

Day 5

4. PROBLEM AREA: Life Cycles, Symptoms, Prevention, and Control of Cattle Parasites

Objectives:

To develop an understanding of:

a. The types of cattle parasites
b. The life cycles, symptoms, prevention, and control of major cattle parasites

1. Screw worms
2. Grubs
3. Flies
4. Stomach worms
5. Lice

To develop an ability to:

a. Recognize parasite infestations in cattle
b. Treat cattle parasites
c. Control cattle parasites

ANIMAL HEALTH

Day 5 (continued)

References:

a. Animal Health, Ch. 7, pp. 49-52; Ch. 8, pp. 53-58

Days 6 and 7

5. PROBLEM AREA: Causes, Symptoms, Prevention, and Control of Major Sheep Diseases

Objectives:

To develop an understanding of:

a. The types of sheep diseases
b. Causes, symptoms, treatment, and prevention of the following diseases of sheep:

1. Foot Rot
2. Mastitis
3. Sore Mouth
4. Overeating Disease
5. Lambing Paralysis
6. Bloat

To develop an ability to recognize disease conditions in sheep that warrant calling a veterinarian

References:

a. Animal Health, Ch. 3, pp. 13-17; Ch. 5, pp. 30-35

Day 8

6. PROBLEM AREA: Life Cycles, Symptoms, Prevention, and Control of Major Sheep Parasites

Objectives:

To develop an understanding of:

a. The types of sheep parasites
b. The life cycles, symptoms, prevention, and control of the following major sheep parasites:

1. Screw Worm
2. Lice
3. Ticks
4. Scabbies
5. Stomach Worm
6. Tapeworms
7. Coccidiosis

ANIMAL HEALTH

Day 8 (continued)

Objectives: (continued)

To develop an ability to:

a. Recognize animal parasite infestations in sheep
b. Treat sheep parasites
c. Control sheep parasites

References:

a. Animal Health, Ch. 7, pp. 49-50; Ch. 9, pp. 59-66

Days 9 and 10

7. PROBLEM AREA: Causes, Symptoms, Prevention, and Control of Major Swine Diseases

Objectives:

To develop an understanding of:

a. The types of swine diseases
b. Causes, symptoms, treatment, and prevention of the following diseases of swine:

1. Cholera
2. Erysipelas
3. Chronic Mycoplasmal Pneumonia
4. Atrophic Rhinitis
5. Brucellosis
6. Flu
7. TGE
8. Leptospirosis
9. MMA

To develop an ability to recognize disease conditions in swine that warrant calling a veterinarian

References:

a. Animal Health, Ch. 3, pp. 13-17; Ch. 6, pp. 36-48

ANIMAL HEALTH

Day 11

8. PROBLEM AREA: Life Cycles, Prevention and Control of Major Swine Parasites

Objectives:

To develop an understanding of:

a. The types of swine parasites
b. The life cycles, symptoms, prevention, and control of the following major swine parasites:

1. Ascarids
2. Lungworms
3. Mange
4. Lice

To develop an ability to:

a. Recognize parasite infestations in swine
b. Treat swine parasites
c. Control swine parasites

References:

a. Animal Health, Ch. 7, pp. 49-50; Ch. 10, pp. 67-71

Day 12

9. PROBLEM AREA: Planning a General Livestock Health Program

Objectives:

To develop an understanding of:

a. The role of sanitation in an animal health program
b. The importance of preventive medicine

To develop an ability to:

a. Plan general livestock health programs
b. Evaluate current livestock health programs

References:

a. Animal Health, Ch. 11, pp. 73-80
b. Animal Health Handbook, pp. 6-7

ANIMAL HEALTH

Day 13

10. PROBLEM AREA: Occupational Roles of the Veterinarian, Farmer and Other Animal Health Workers

Objectives:

To develop an understanding of:

a. The occupational roles for veterinarians, farmers, and other animal health workers
b. Opportunities for employment in the field of animal health

To develop an ability to care for sick animals

References:

a. Animal Health, Ch. 12, pp. 81-87
b. Animal Health Handbook, pp. 36-38

Day 14

11. PROBLEM AREA: Summary and review

Objectives:

To review previously covered material and answer student questions

References:

a. All previous assignments

COMMERCIAL FERTILIZERS

COMMERCIAL FERTILIZERS

Problem Area Outline by Days

Day	
1	Influence of Fertilizers on Farming
2 & 3	Essential Plant Food Elements and Their Function in Plant Growth
4	Hunger Signs of Crops
5 & 6	Taking a Soil Sample
7	Liming to Correct Soil Acidity
8 & 9	Understanding the Soil Test Report
10	Determining the Amount of Nutrients Available in the Soil
11	Determining Fertilizer Application Rates
12 & 13	Selecting Fertilizer Materials to Fill Nutrient Needs
14	Summary and Review
15	Post-Test

COMMERCIAL FERTILIZERS

Behavioral Objectives: (understandings and abilities)

Understanding of:
1) The influence of fertilizers on farming
2) The essential plant food elements and their function in plant growth
3) The effect of soil acidity on crop production

Ability to:
1) Recognize hunger signs of crops
2) Take a soil sample
3) Correct soil acidity by liming
4) Interpret the soil test report
5) Determine the amount of nutrients available in the soil
6) Determine fertilizer application rates
7) Select fertilizer materials to fulfill nutrient needs

COMMERCIAL FERTILIZERS

Day 1

1. PROBLEM AREA: Influence of Fertilizers on Farming

Objectives:

To develop an understanding of:

a. The benefits to be gained from fertilizing
b. The increase in fertilizer use in Iowa and the local community
c. The need to maintain soil fertility
d. How plant food is lost

References:

a. Our Land and Its Care, pp. 2-21, 62-65, 67-68
b. Fertilizer Use in Iowa Reaches Record Level, Iowa Farm Service Publication No. 1231

Days 2 and 3

2. PROBLEM AREA: Essential Plant Food Elements and Their Function in Plant Growth

Objectives:

To develop an understanding of:

a. The essential plant food elements and their function in plant growth
   (1) Primary nutrients and their function in plant growth
      (a) The function of nitrogen in plant growth
      (b) The function of phosporus in plant growth
      (c) The function of potassium in plant growth
   (2) Secondary plant nutrients and their function in plant growth
      (a) The function of calcium in plant growth
      (b) The function of magnesium in plant growth
      (c) The function of sulfur in plant growth
   (3) Micro plant nutrients and their function in plant growth

References:

a. Our Land and Its Care, pp. 23, 26-34
b. Growth and Nutrient Uptake by Corn, Pamphlet 277

COMMERCIAL FERTILIZERS

Day 4

3. PROBLEM AREA: Hunger Signs of Crops

Objectives:

To develop an understanding of nutrient requirements of various crops

To develop an ability to:

a. Recognize primary plant food deficiencies
b. Recognize secondary plant food deficinecies
c. Recognize micro plant food deficiencies

References:

a. Our Land and Its Care, pp. 36-39
b. Be Your Own Corn Doctor -- NPK Bulletin

Days 5 and 6

4. PROBLEM AREA: Taking a Soil Sample

Objectives:

To develop an understanding of:

a. The effect of soil types on soil fertility
b. The effect of cropping sequence on soil fertility
c. Where soil samples may be analyzed

To develop an ability to:

a. Take a uniform and representative soil sample
b. Correctly fill out the soil and cropping information sheet

References:

a. How to take a Soil Sample, NPK Leaflet
b. Our Land and Its Care, p. 42
c. Soil and cropping Information Sheet, ST-8

Day 7

5. PROBLEM AREA: Liming to Correct Soil Acidity

Objectives:

To develop an understanding of:

a. What is soil acidity and how it is measured
b. The optimum pH range for farm crops
c. The effective calcium carbonate equivalent (ECCE) of various liming materials

To develop an ability to:

a. Correct soil acidity
b. Select proper liming materials
c. Determine proper liming rates

References:

a. Our Land and Its Care, pp. 18-19
b. Understanding Your Soil Test Report, Pamphlet 429, p. 5
c. Your Limestone Recommendation, (St-2)

Days 8 and 9

6. PROBLEM AREA: Understanding the Soil Test Report

Objectives:

To develop an understanding of:

a. What a soil test measures
b. How the amount of N, P, and K are determined by a soil test

To develop the ability to:

a. Select the correct soil test nutrient recommendation
b. Adjust soil test recommendations to specific crop yields

References:

a. Understanding Your Soil Test Report, Pamphlet 429, pp. 1-4
b. Soil Test Report, (ST-9)

COMMERCIAL FERTILIZERS

Day 10

7. PROBLEM AREA: Determining the Amount of Nutrients Available in the Soil

Objectives:

To develop the ability to estimate:

a. The nitrogen credits for 1st or 2nd corn following a legume
b. The amount of carryover available from fertilizer applied the previous year
c. The amount of nutrients supplied from manure that has been applied since soil was sampled

References:

a. Understanding Your Soil Test Report, Pamphlet 429, pp. 1-4
b. Modern Farmers Need to be Accountants in the Cornfield, Iowa Farm Service Publication No. 1049

Day 11

8. PROBLEM AREA: Determining Fertilizer Application Rates

Objectives:

To develop an understanding of the factors that affect fertilizer application rates:

a. Nutrient requirements from soil test report
b. Nutrients available in the soil

To develop the ability to:

a. Calculate proper fertilizer application rates
b. Convert P_2O_5 to Phosphorous
c. Convert K_2O to Potassium

References:

a. Understanding Your Soil Test Report, Pamphlet 429, pp. 2-4
b. Better Names for "Phosphate" and "Potash", Iowa Farm Service Publication No. 1050

Days 12 and 13

9. PROBLEM AREA: Selecting Fertilizer Materials to Fill Nutrient Needs

Objectives:

To develop an understanding of the major sources of fertilizer materials available in the community

To develop the ability to:

a. Change nutrient recommendations into amounts of a fertilizer grade
b. Select fertilizer materials that will fulfill nutrient needs

References:

a. Understanding Your Soil Test Report, Pamphlet 429, pp. 5-6
b. Our Land and Its Care, pp. 44-45, 56, 57

Day 14

10. PROBLEM AREA: Review and Summary

Objectives:

To review previous material covered in this partial unit

References:

a. Those cited for each of the problem areas studied

SMALL GASOLINE ENGINES

SMALL GASOLINE ENGINES

Problem Area Outline by Days

Day	
1	Engine Principles - Two and Four-cycle Engines
2	Nomenclature - Compression Factors
3	Valves
4	Valve Timing - Camshafts
5	Rings
6	Measuring Devies
7	Carburetion
8	Carburetor Types
9	Carburetor Adjustment - Governors
10	Air Cleaners
11	Ignition Systems
12	Magneto Cycle
13	Preventative Maintenance
14	Trouble Shooting - Review
15	Post-Test

SMALL GASOLINE ENGINES

Behavioral Objectives: (understanding and abilities)

Understanding of:

1) Basic principles of small engine operation
2) Difference between two and four-stroke cycle engines
3) Function of piston, rings, crankshaft, camshaft, and valves as related to compression
4) Fuction of carburetor and component parts
5) Function of small engine ignition systems and component parts
6) Measuring devices used on small engines

Ability to:

1) Identify basic small engine components
2) Perform general maintenance on a small gasoline engine
3) Trouble shoot a small gasoline engine
4) Use various measuring and testing devices
5) Use a service manual

SMALL GASOLINE ENGINES

Day 1

1. PROBLEM AREA: Engine principles - Two and Four-Cycle Engines

Objectives:

To develop an understanding of:

a. The intake stroke, compression stroke, power stroke and exhaust stroke in an engine
b. The principles of operation of a two and four-cycle engine

References:

a. General Theories of Operation, Briggs & Stratton, Corp., pp. 2-3
b. Small Gasoline Engines Student Handbook, Penn. State Univ. pp. 1-3

Day 2

2. PROBLEM AREA: Nomenclature - Compression Factors

Objectives:

To develop an understanding of piston displacement and compression ratio as related to horsepower in a small engine

To develop an ability to:

a. Identify main parts of small engines
b. Calculate piston displacement and compression ratio

References:

a. General Theories of Operation, Briggs & Stratton, lorp., p. 4
b. Small Gasoline Engines Student Handbook, Penn. State Univ. p. 4

SMALL GASOLINE ENGINES

Days 3 and 4

3. PROBLEM AREA: Valves, Valve Timing and Camshafts

Objectives:

To develop an understanding of:

a. Valve operating conditions
b. Valve failures

To develop an ability to:

a. Identify parts of valve train
b. Determine usable valve margin and valve seat tolerances

References:

a. General Theories of Operation, Briggs & Stratton, Corp., pp. 4-7
b. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 5-7

Day 5

4. PROBLEM AREA: Ring Adjustment

Objectives:

To develop an understanding of:

a. The purpose of rings
b. Ring types and each's function

To develop an ability to:

a. Measure various ring clearances
b. Identify types of rings

References:

a. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 8-11

SMALL GASOLINE ENGINES

Day 6

5. PROBLEM AREA: Measuring Devices

Objectives:

To develop an understanding of various measuring devices

To develop an ability to read micrometer and other measuring devices

References:

a. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 12-19

Days 7, 8, and 9

6. PROBLEM AREA: Carburetion, Carburetor Types and Adjustment, and Governors

Objectives:

To develop an understanding of:

a. Principles of operation of carburetors
b. How gaseous mixture is controlled within the carburetor
c. Governor types and operation

To develop an ability to:

a. Identify basic parts of the carburetor
b. Explain operation of various types of carburetors
c. Governor types and operation

References:

a. General Theories of Operation, Briggs & Stratton, Corp., pp 8-13, 20-21
b. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 27-37

SMALL GASOLINE ENGINES

Day 10

7. PROBLEM AREA: Air Cleaners

Objectives:

To develop an understanding of:

a. The importance of an air cleaner
b. The different types and principles of operations of air cleaners

To develop an ability to service various types of air cleaners

References:

a. General Theories of Operation, Briggs & Stratton, Corp., p. 14
b. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 37-39

Days 11 and 12

8. PROBLEM AREA: Ignition and the Magneto Cycle

Objectives:

To develop an understanding of:

a. The purpose of ignition systems

b. Principles of magneto-ignition systems
c. A complete magneto cycle

To develop an ability to:

a. Identify parts of magneto-ignition system

References:

a. General Theories of Operation, Briggs & Stratton, Corp., pp. 15-18
b. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 45-51

SMALL GASOLINE ENGINES

Day 13

9. PROBLEM AREA: Preventative Maintenance

Objectives:

To develop an understanding of:

a. The importance of maintenance on small gasoline engines
b. Why clean, fresh, regular gasoline should be used in small gasoline engines

To develop an ability to:

a. Determine and analyze engine problem by observation of spark plug
b. Properly service engine at proper time (spark plugs, breaker points, air cleaners and oil)
c. Properly prepare small gasoline engine for storage
d. Follow a service and maintenance schedule

Reference:

a. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 55-59

Day 14

10. PROBLEM AREA: Trouble Shooting and Review

Objectives:

To develop an understanding of procedures used in trouble shooting

To develop an ability to trouble shoot an engine

Reference:

a. Small Gasoline Engines Student Handbook, Penn. State Univ., pp. 64-65

FARM CREDIT

FARM CREDIT

Problem Area Outline by Days

Day	
1	Introduction to Credit, "Problem"
2	"Problem", Application for Loan (Financial Statement)
3	Budgeting Principles
4	Budgeting the Problem
5	Budgeting, Complete Application for Loan
6	Types of Loans
7	Sources of Credit - Short Term & Intermediate
8	Sources of Credit - Long Term - (Land)
9	Interest Rates and Loan Costs
10	Collateral - Short and Intermediate Term
11	Collateral - Long Term
12	Credit Instruments - Short Term - Intermediate
13	Credit Instruments - Long Term - (Land)
14	Summary and Review
15	Post-Test

FARM CREDIT

Behavioral Objectives: (understandings and abilities)

Understanding of:

1) The importance of credit in agriculture
2) Types of credit used for specific purposes
3) The sources of credit
4) Interest rates and loan costs
5) Credit instruments
6) The criteria used in granting farm credit
7) The criteria used to evaluate a credit source
8) The career potentials in farm credit

Ability to:

1) Use credit to increase farm income
2) Budget income and expenses to determine credit needs
3) Select correct credit source based on financial position and needs
4) Calculate the cost of various types of loans
5) Use credit instruments
6) Prepare a financial statement
7) Plan a repayment schedule

FARM CREDIT

Days 1 and 2

1. PROBLEM AREA: The Problem

Objectives:

To develop an understanding of the need for credit

To develop an ability to:

a. Analyze a farming situation and determine the financial position of the applicant
b. Prepare a financial statement

References and Materials:

a. Financing Farm & Ranch Activities, pp. 8-11, 15
b. The Problem
c. Financial statement form

Days 3, 4, & 5

2. PROBLEM AREA: Budgeting

Objectives:

To develop an understanding of budgeting principles

To develop an ability to budget a farm credit problem

References and Materials:

a. Financing Farm & Ranch Activities, pp. 34, 36-37
b. The Problem
c. Budget Worksheet
d. Application for loan

FARM CREDIT

Day 6

3. PROBLEM AREA: Types of Loans (based on length of loan in years)

Objectives:

To develop an understanding of:

a. The three types of loans normally available
b. Disadvantages and advantages of various types of credit

To develop an ability to classify credit requirements into loan types

References and Materials:

a. Financing Farm & Ranch Activities, pp. 12-13

Days 7 & 8

4. PROBLEM AREA: Sources of Credit

Objectives:

To develop an understanding of:

a. The sources of credit
b. An understanding of the criteria used to evaluate a credit source

To develop an ability to determine the type of credit source to use

References and Materials:

a. Financing Farm & Ranch Activities, pp. 32-41, 50-66

FARM CREDIT

Day 9

5. PROBLEM AREA: Interest Rates and Loan Costs

Objectives:

To develop an ability to calculate the costs of various types of loans

References and Materials:

a. Financing Farm & Ranch Activities, pp. 18-19, 47-50

Days 10 & 11

6. PROBLEM AREA: Collateral

Objectives:

To develop an understanding of the criteria used in granting farm credit

To develop an ability to determine loan value of different types of collateral

References and Materials:

a. Financing Farm & Ranch Activities, pp. 14-17, 44-47

FARM CREDIT

Days 12 and 13

7. PROBLEM AREA: Credit Instruments

Objectives:

To develop an understanding of the types of credit instruments

To develop an ability to use credit instruments

References and Materials:

a. Financing Farm & Ranch Activities, pp. 19-29, 35-39
b. Blank credit instrument forms

Day 14

8. PROBLEM AREA: Summary

Objectives:

To develop an understanding of the career potentials in farm credit work

To review previous problem area objectives

References and Materials:

a. Financing Farm & Ranch Activities
b. The Problem
c. Budget Worksheet
d. Application for loan
e. Credit instruments